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Early Generation Seed Study

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This report was prepared for the Bill and Melinda Gates Foundation and USAID in collaboration with Monitor Deloitte

Bill and Melinda Gates Team: Walter de Boef

USAID Team: Mark Huisenga, David Atwood

Monitor Deloitte Team: John Mennel, Kurt Dassel, Pradeep Prabhala, Jessica Weddle, Kelsey Anderson, Michael Taintor

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Context and objectives of this study

Quality seed of improved varieties is difficult to access in many countries in Sub-Saharan Africa partly due to bottlenecks in the early generation seed (EGS) value chain. In the formal seed sector, there are many constraints to accessing publicly bred varieties, and the private sector often does not operate at sufficient scale to fill the gaps. One reason for this is that current policies do not always support efficient models for scaling production and delivery of EGS. Seed policy is either too general, treating all EGS as a public good with heavy state involvement, or too specific, applying idiosyncratic policies for specific crops in specific countries or regions. As a result, formal seed systems remain small, improved varieties are not effectively commercialized, and access to quality seed is limited.

While we recognize the critical role of informal seed systems now and in the future, scaling the formal seed sector will be critical to increasing availability of quality seed of improved varieties. To address this challenge, this report seeks to develop a generalizable framework that enables policy makers and donors to tailor their policies and interventions to the needs of specific crops based on market conditions, which we refer to in this study as market archetypes. The archetypes are determined by the following dimensions:

- Marginal economic value of quality seed of improved varieties
- Level of demand for varieties or crops grown with quality seed of improved varieties

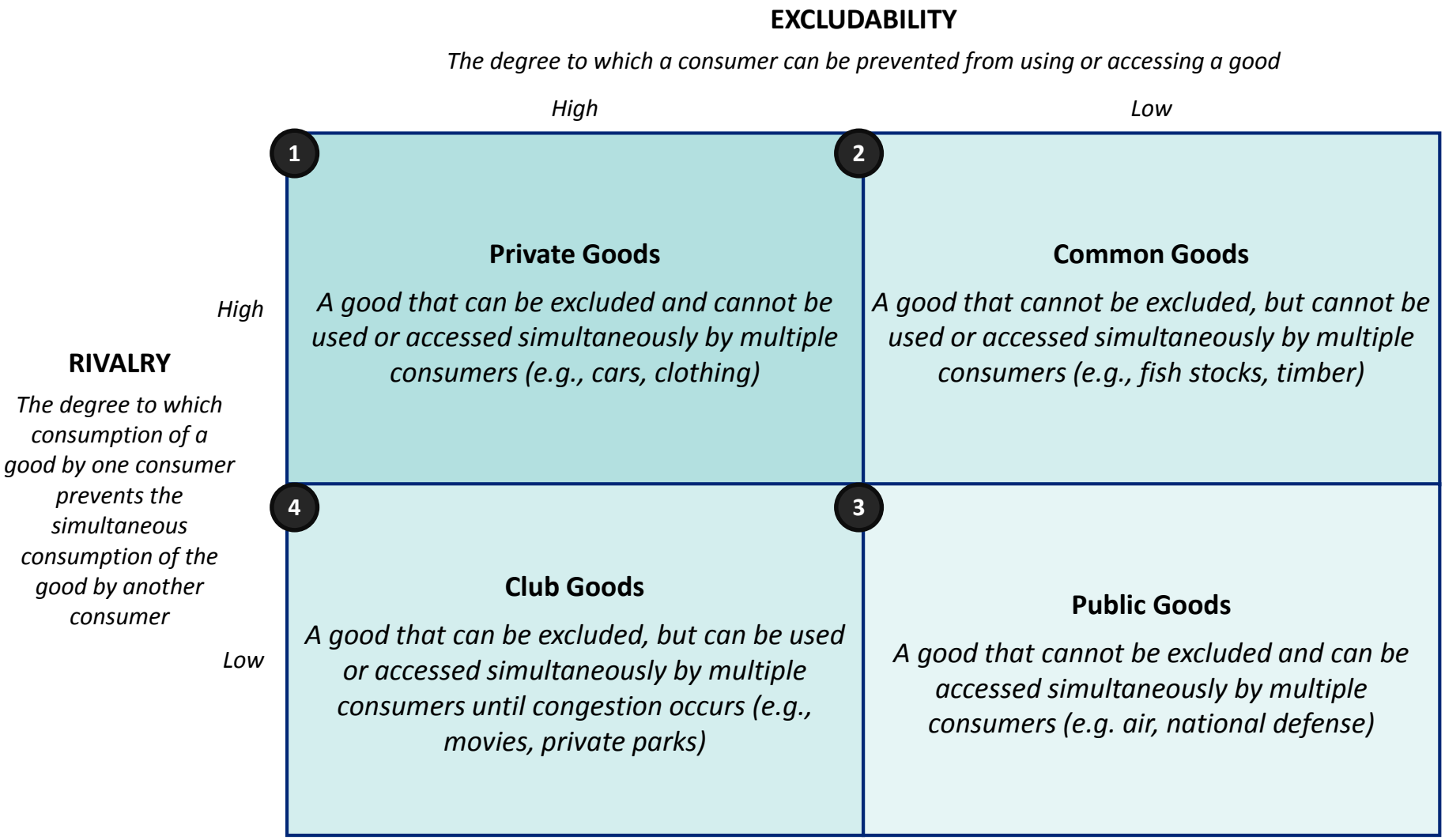
We recognize, however, that several other factors contribute to a well-functioning formal seed sector, which we address in this report. These include, but are not limited to:

- Policy Environment: National and regional policies, including subsidies, tax exemptions, and the farmers' rights, biodiversity, IP and other rules and regulations which emanate from these policies; the level of coordination of development interventions
- Value Chain Capacity and Resources: Capacity and resources across the seed value chain (e.g., institutional capacity, personnel, equipment, research funds, etc.); flow of information along the seed value chain
- Quality Assurance Mechanisms: Organization and implementation of quality assurance mechanisms across the seed value chain
- Supporting Environment: Quality of physical infrastructure (e.g., roads, irrigation, etc.); access to capital and financing; capacity and legal framework for farmers' organizations and participation in seed systems

Based on a representative set of countries and crops, we provide real examples of potential business models that could scale in a commercially sustainable manner. For areas that are best suited to public sector investment, we outline where there are opportunities for public-private collaboration and increased efficiencies in the sector. We recognize that achieving the quality of seed demanded by the market at the time it is demanded is a significant challenge separate from achieving a certain quantitative scale. However, our business models assume that seed produced would meet these quality and timing requirements. Further study is needed to understand how the capabilities of specific seed-producing entities in specific geographies might affect these models.

Finally, the report concludes by providing generalizable principles and recommendations to help guide key stakeholders as they pursue policies, investments, and interventions.

For the purposes of this study, we leveraged a common economic framework to define public and private goods



To apply this framework to the Early Generation Seed sector, we adapted the definitions of excludability and rivalry based on the economic characteristics of seed

EXCLUDABILITY: Marginal economic value of quality seed of improved varieties

The degree to which downstream seed producers and farmers must rely on EGS from a given producer in order to obtain desirable traits and high quality at the level demanded by the market.

Key variables include but are not limited to:

- Frequency with which quality seed must be bought to maintain performance and vigor of an improved variety
- Existence of differentiating characteristics that command a price premium
- Hardiness of seed or planting material to withstand storage and transportation with minimal loss
- Presence of significant upside to continuous improvement and innovation *(increased productivity and plant yield from technological improvements in improved varieties; replacement of varieties represent potential upside)*
- Labor, input, and technology intensity of producing seed

RIVALRY: Level of demand for varieties or crops grown with quality seed of improved varieties

The degree of pluralism expected in the market based on the number of farmers demanding quality seed of improved varieties and, in turn, the number of downstream producers demanding quality EGS of those varieties.

Key variables include but are not limited to:

- Total demand for all varieties of the crop in applicable markets
- Market quality standards
- Sophistication of farmer demand for varieties, which may be correlated to different geographic markets and end markets for processed products
- Sophistication of end-market consumers of the crop, which may be correlated to different geographic markets
- Specialization of demand for varieties with specific defining characteristics, e.g. aroma, color, etc.

To analyze the economics of EGS, we applied a common economic framework, which we adapted to highlight the economic characteristics of seed that have implications for ideal state value chains

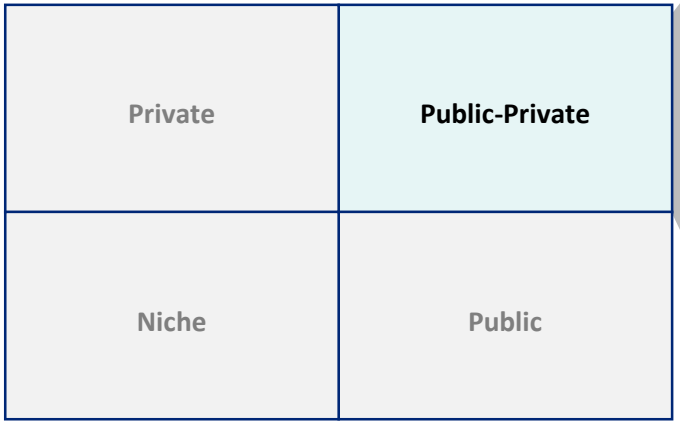
Marginal economic value of quality seed of improved varieties

Level of demand for crops grown with quality seed of improved varieties

	High	*Low*
High	**1 Private Sector Dominant Archetype** *Quality seed of improved varieties that is both attractive for private sector actors to produce and that produces crops the market demands, resulting in robust private sector investment with minimal public sector involvement* **Example seed sectors:** Maize (hybrid) *Flowers*[3] *Vegetables (tomatoes, cabbage, etc.)*	**2 Public-Private Collaboration Archetype** *Quality seed of improved varieties for crops with strong market demand but for which the cost of production or demand risk create barriers to private-sector investment and innovation resulting in public sector involvement* **Example seed sectors:** Maize (OPV)[1] Cowpea[2] Common Bean[2] Rice Cassava Sweet Potato *Groundnut*
Low	**4 Niche Private Sector Archetype** *Quality seed of improved varieties for crops with niche market demand but which are profitable to produce in certain quantities, which are produced by a vertically integrated private sector with minimal public involvement* **Example seed sectors:** Sweet potato (temporary demand due to disease) *Cotton* Sorghum or Cassava (niche demand for beer brewing)	**3 Public Sector Dominant Archetype** *Quality seed of improved varieties for crops that are not highly desirable or profitable to produce, but which are promoted by the public sector to advance a public goal such as food security or seed security* **Example seed sectors:** Sorghum (OPV) *Teff* Common Bean[2] Cowpea[2]

Notes:
(1) Examples are relevant for quality seed of improved varieties in formal seed sectors
(2) In the context of this slide, "quality seed of improved varieties" refers to commercial quality seed, not EGS
(3) Examples given are illustrative and may not be applicable across all countries and crop varieties, which accounts for the same crop appearing in more than one box
(4) Examples in *italics* indicate crops that were outside the scope of this study's target crops

Within the public-private collaboration category we identified two archetypes based on the certainty of demand, cost, and complexity of supply



Uncertain market demand

2a

Public-Private Archetype I: Public Sector Mitigates Demand Risk

Seed that is attractive for private sector companies to produce, but for which they cannot reliably forecast demand and so are exposed to high demand risk and high cost of capital as a result

Example seed sectors:

Rice Sweet Potato

Cassava

Costly / complex production

2b

Public-Private Archetype II: Public Sector Supports Breeder and Foundation Seed Production

Seed that is reliably demanded by consumers, but which are unattractive to produce EGS for due to high effort or technology intensity, risk of post-production loss, or generally low margins

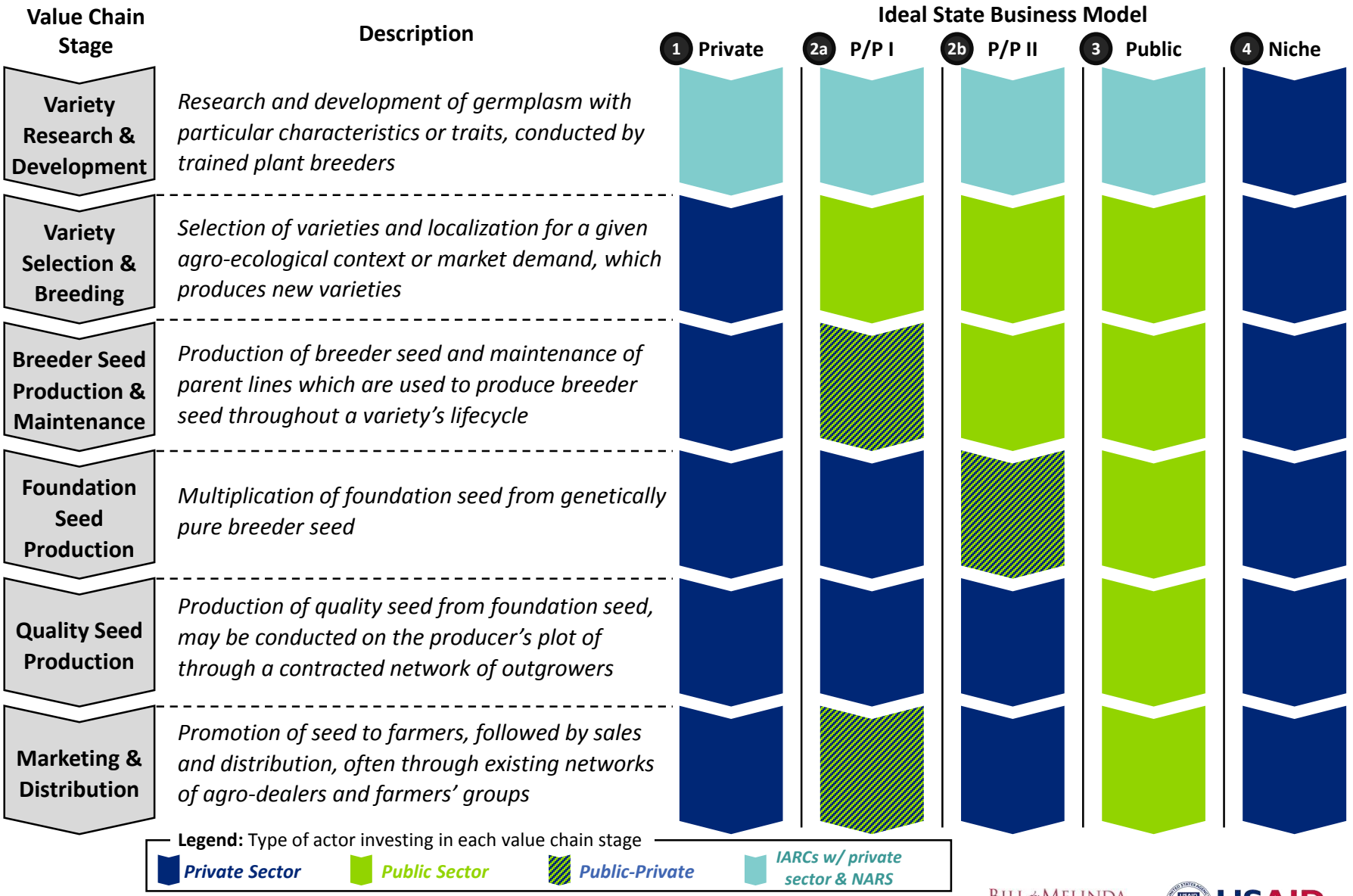
Example seed sectors:

Cowpea Maize (OPV)

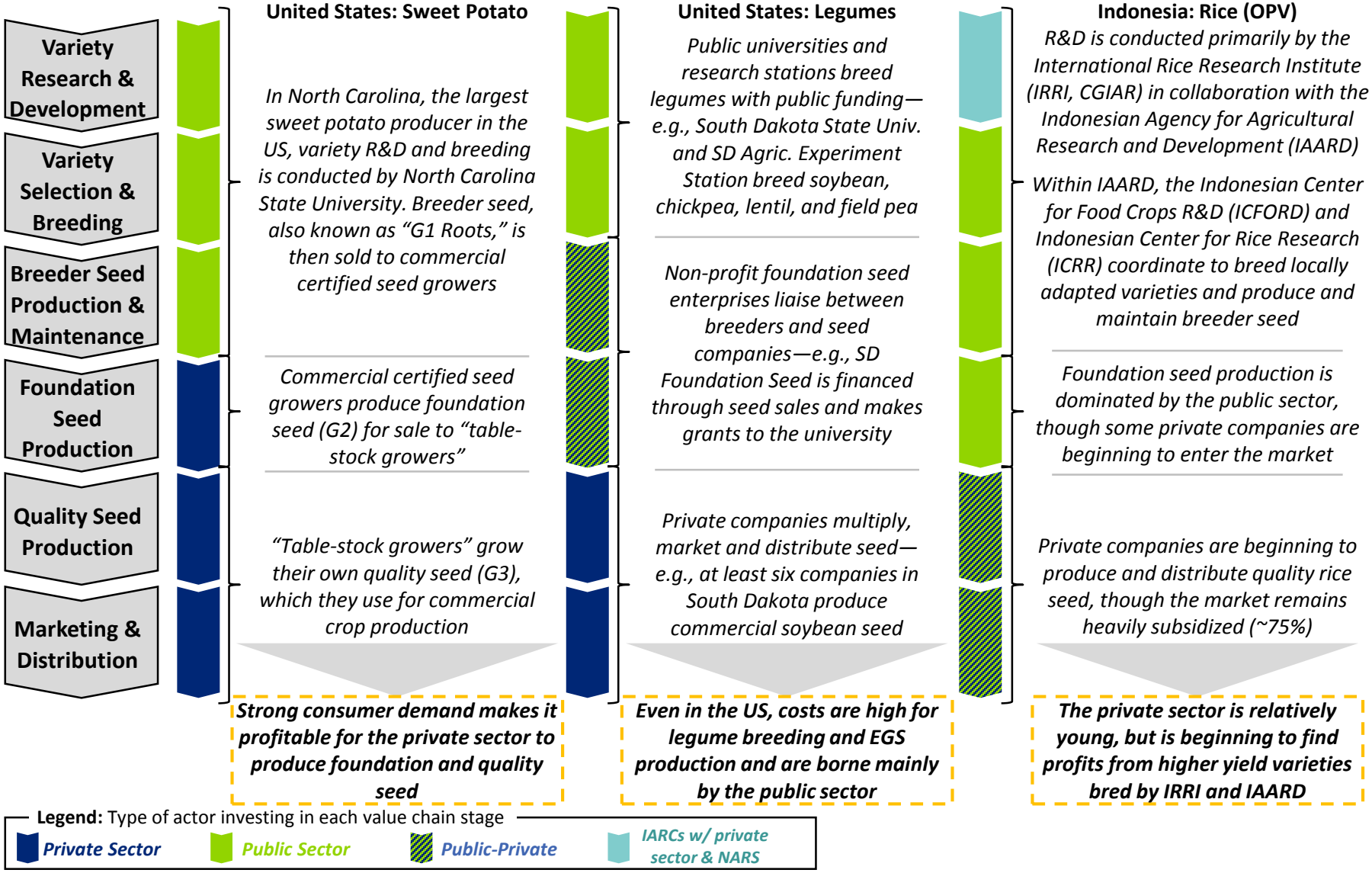
Common bean

Notes:
(1) Examples are relevant for quality seed of improved varieties in formal seed sectors
(2) Examples given are illustrative and may not be applicable across all countries and crop varieties, which accounts for the same crop appearing in more than one box

Within each archetype, the ideal state of who invests at each value chain stage is determined by who derives value from the activity, though the work may be contracted to other actors



Examples of seed sectors in other regions illustrate the variety of business models that support successful scaling of production and delivery of early generation seed



Sources: NC State University. NCSweetPotatoes.com South Dakota State University, IRRI, Indonesian Agency for Agricultural Research and Development, Indonesian Center for Agricultural, Socio-Economic and Policy Studies

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Market Archetype Descriptions

The following archetype descriptions are intended to describe the unique seed and demand characteristics that create the market conditions for each market archetype.

We have also laid out an illustrative “ideal state business model” to scale production and delivery of quality seed of improved varieties. Specific crop examples are illustrative and may not be applicable in all markets.

1 Private sector investment and involvement in the EGS sector occurs when seed is highly profitable and when the demand is high and stable

Private	P/P
Niche	Public

	Description	Example: Hybrid Maize
Seed Characteristics *Inherent characteristics of the crop and seed's biology and associated agricultural practices that impact the design and viability of seed systems*	• Quality seed must be bought frequently to maintain performance and crop quality • Quality seed from the formal sector is seen as providing a significant quality benefit over farmer-saved or informally sourced seed • Improved varieties offer significant benefits in certain desirable traits over local and recycled improved varieties • Seed can be efficiently distributed to consumers	• Must be purchased every year to maintain hybrid vigor and desirable traits • Maize seed are hardy and transportable, as they have low bulk and low perishability • Improved varieties offer large yield advantages over local and recycled improved varieties
Demand Characteristics *Economic characteristics of the end market for crops that impact the incentives of various players within seed systems*	• High market demand for the end-market crop in general, from public or private consumers • High standards of quality in market, resulting in increased demand for quality seed of improved varieties to produce high-quality and uniform crops • Specialized demand for the variety or crop carrying specific characteristics (aroma, color) • Continuous innovation in improved varieties is valued by the market	• Quality seed of hybrid varieties is highly valued, selling for a much higher multiple of grain price on average, as opposed to OPVs • Continuous improvement is critical to growing agricultural productivity, and maize is an important staple crop in much of Sub-Saharan Africa

Source: Boettiger, Sara et al. "Planning for Scale Brief #1: Tools for Scaling," Ag Partner Exchange, 2013, Figure 2, page 18; Interviews with crop and country experts

Private Sector Dominant Archetype

1 In this archetype, private actors produce EGS and distribute it through commercial markets, often in the context of a well-developed, mature enabling environment

Private	P/P
Niche	Public

Value Chain Stages	Ideal State Business Model: Key Actors and Roles	*Illustrative Ideal State: Hybrid Maize*
Variety Research & Development	• ***International research centers (e.g., CIMMYT)*** develop new germplasm that has generally desirable characteristics, sometimes in collaboration with private companies	***International center (e.g., CIMMYT)*** develops new varieties, and licenses on an exclusive or non-exclusive basis in exchange for royalties
Variety Selection & Breeding	• ***Private seed companies (domestic or MNC)*** maintain parent lines and produce subsequent generations of parental lines as a subset of breeder seed	***Private companies***, e.g. Zamseed, select and breed for locally adapted lines best suited to Zambian growing conditions and market needs and conduct maintenance breeding
Breeder Seed Production & Maintenance	• ***Private seed companies*** maintain parent lines and produce subsequent generations of parental lines as a subset of breeder seed	***Private companies*** like Zamseed maintain inbred parent lines and either licenses varieties to other companies or use them in-house
Foundation Seed Production	• ***Private seed companies*** produce foundation seed from breeder seed of varieties that they either maintain in-house or license from another private entity	***Private companies*** produce and market foundation seed for profit or uses it in-house or with outgrowers to produce quality seed
Quality Seed Production	• ***Private seed companies*** manage production of quality seed from foundation seed either through contractual arrangements with outgrowers or on their own plots	***Private companies*** produce quality seed primarily through contract growers to whom they provide foundation seed
Marketing & Distribution	• ***Private seed companies*** set prices in the market and either develop in-house marketing and distribution or interface with NGOs, agro-dealers, coops, unions, etc.	***Private companies*** repurchase seed from contract growers and market to local farmers' groups and agro-dealer networks

Legend: Type of actor investing in each value chain stage

Private Sector | *Public Sector* | *Public-Private* | *IARCs w/ private sector & NARS*

2a Public-Private Archetype 2a: When the demand for EGS is uncertain, the public may need to play a role in mitigating demand risk

Private	P/P
Niche	Public

	Description	Example: Rice
Seed Characteristics *Inherent characteristics of the crop and seed's biology and associated agricultural practices that impact the design and viability of seed systems*	• Because farmers can easily save, produce, and market seed in informal markets, demand for seed from the formal sector is not guaranteed from year to year – Demand is driven by a need for quality seed or new varieties • Performance of seed is highly sensitive to variable growing conditions each season, i.e. rainfall, resulting in uncertain or inconsistent demand	• Rice seed can be recycled for several years, so farmers only renew every few years • Rice is highly sensitive to rainfall conditions, with recurring, but uncertain demand for new drought resistance varieties • Demand exists for new varieties with clear value added to farmers that may ensure yield
Demand Characteristics *Economic characteristics of the end market for crops that impact the incentives of various players within seed systems*	• Farmer adoption of improved varieties and their value is low and requires promotion • Consumer preference can be fickle based on grain characteristics (size, color, etc.), though market pull exists among wealthier, urban consumers for high-quality, non-broken grain • Consumer preferences shifting based on socio-economic trends (e.g., increasing wealth)	• Adoption of improved varieties is slow • Competition from imported rice reduces demand for domestic rice and, hence, seed • Meeting consumer preferences on uniformity of grain size, transparency, and non-broken grains can be a source of price premiums, which requires quality seed along with strong agricultural and post-harvest practices • Perception that demand will decrease as GDP rises and more high-end grains are demanded

Source: Boettiger, Sara et al. "Planning for Scale Brief #1: Tools for Scaling," Ag Partner Exchange, 2013, Figure 2, page 18; Interviews with crop and country experts

2a Under P/P Archetype 2a, private companies produce EGS and commercial seed, and the public sector mitigates demand risk through contractual or financial arrangements

Private	P/P
Niche	Public

Value Chain Stages	Ideal State Business Model: Key Actors and Roles	*Illustrative Ideal State: Sweet Potato*
Variety Research & Development	• ***International research centers (e.g., IITA)*** develop new germplasm that has generally desirable characteristics, sometimes in collaboration with NARS	***International center (e.g., CIP)*** breeds new varieties of sweet potato, for example high-starch, high DMC varieties for frying and consumption, as preferred by farmers and consumers
Variety Selection & Breeding	• ***Public breeding programs*** select germplasm based on local adaptability and desirability and breed for locally adapted varieties	***NARS (e.g., DRD in Tanzania)*** select and breed for adapted varieties best suited for end-market demands and agro-ecological context
Breeder Seed Production & Maintenance	• ***Public-private partnership or non-profit entity*** maintains breeder seed/plant material as an intermediary between the public sector and private seed companies	***NARS*** contracts with ***private tissue culture lab*** to maintain and produce breeder seed/planting material on an ongoing basis
Foundation Seed Production	• ***Domestic seed companies*** produce foundation seed from public breeder seed of varieties that they license from a non-profit intermediary entity	***Private foundation seed enterprise (FSE)/nurseries*** licenses varieties in response to demand and produces and markets foundation seed for profit
Quality Seed Production	• ***Domestic seed companies or farmers organizations*** manage production of quality seed from foundation seed, possibly using outgrowers	***Private, domestic companies*** produce quality planting material through local contract growers to minimize downstream transport costs of bulky planting material
Marketing & Distribution	• ***Public sector*** guarantees demand either by buying seed directly from private companies in output-based contractual arrangements or through policy measures	***Public sector*** collaborates with ***private sector*** to guarantee demand by incentivizing private companies to purchase and use more sweet potato, for example in fuel or bread production

Legend: Type of actor investing in each value chain stage

Private Sector ***Public Sector*** ***Public-Private*** ***IARCs w/ private sector & NARS***

2b

Public-Private Archetype 2b: When EGS is unattractive to produce despite the level of demand, the public sector will support the supply

Private	P/P
Niche	Public

	Description	Example: Common Bean and Cowpea
Seed Characteristics *Inherent characteristics of the crop and seed's biology and associated agricultural practices that impact the design and viability of seed systems*	• Seed is highly labor or technology-intensive to produce or to handle/store post-harvest • Seed is fragile or sensitive and thus difficult to store and transport to farmers without loss • Size or weight of seed makes it costly to transport for production and distribution • Multiplication yield rates are low making the multiplying seed costly	• Multiplication rates are low (esp. for common bean) and it is costly to multiply more than once per year, due to irrigation and input costs, increasing the time and cost of multiplication • The large size (of common bean, specifically) and heavy weight of the seed makes transportation costs high which, combined with the difficulty of post-harvest handling, causes distribution challenges in areas with poor infrastructure (poor trucking systems and roads)
Demand Characteristics *Economic characteristics of the end market for crops that impact the incentives of various players within seed systems*	• Low prices in end-markets depress margins • Reuse of varieties for long periods of time in market reduces incentives to produce quality seed and in the long term, reduces incentives to invest in research and development of new varieties • Farmers re-use seed for many seasons before repurchasing quality seed of improved varieties	• Landraces can be used for 20-30 years in-market, creating little market pull for improved varieties • Farmers reuse seed for ~3-5 years depending on skill before repurchasing improved varieties (little ROI incentive to repurchase quality seed of improved varieties year over year)

Source: Boettiger, Sara et al. "Planning for Scale Brief #1: Tools for Scaling," Ag Partner Exchange, 2013, Figure 2, page 18; Interviews with crop and country experts

2b Under P/P Archetype 2b, public actors produce EGS and sell it in a commercial market to private seed companies for quality seed production and distribution

Private	P/P
Niche	Public

Value Chain Stages	Ideal State Business Model: Key Actors and Roles	*Illustrative Ideal State: Cowpea*
Variety Research & Development	• ***International research centers (e.g., IITA/CIAT)*** develop new germplasm that has generally desirable characteristics, sometimes in collaboration with NARS	***International center (e.g., IITA)*** breeds new varieties with superior taste or tolerance to environmental conditions
Variety Selection & Breeding	• ***Public breeding programs*** select germplasm based on local adaptability and desirability and breed first generation breeder seed	***NARS (e.g., Savannah Agricultural Research Institute in Ghana)*** select and breeds varieties for diverse agro-ecological regions of Ghana, on a regional basis for the dryer, northern regions
Breeder Seed Production & Maintenance	• ***Public breeding programs*** maintain and produce breeder seed	***NARS*** produces public breeder seed and maintains it on an ongoing basis in order to supply inputs for foundation seed producers
Foundation Seed Production	• ***Public-private partnership or non-profit entity*** produces foundation seed and licenses varieties to seed producers on a cost-recovery basis	***Non-profit foundation seed enterprise (FSE)*** licenses varieties from public breeding programs and produces and markets foundation seed to private companies on a cost recovery basis
Quality Seed Production	• ***Domestic seed companies or farmers organizations*** manage production of quality seed from foundation seed, possibly using outgrowers	***Private, domestic companies*** produce quality seed through local contract growers to minimize downstream transport costs of bulky seeds
Marketing & Distribution	• ***Domestic seed companies or farmers organizations*** set prices and either develop in-house marketing and distribution or leverage NGOs, agro-dealers, coops, etc.	***Private, domestic companies*** manage and facilitate distribution to local agro-dealers or farmer's groups

Legend: Type of actor investing in each value chain stage

Private Sector | *Public Sector* | *Public-Private* | *IARCs w/ private sector & NARS*

3 Strong public involvement in EGS occurs when seed is not profitable or when the output crops have low commercial demand but may be valuable for public goals

Private	P/P
Niche	**Public**

	Description	Example: Sorghum (OPV)
Seed Characteristics *Inherent characteristics of the crop and seed's biology and associated agricultural practices that impact the design and viability of seed systems*	• Seed can be saved from season to season by farmers with limited decline in seed quality and varietal performance • Seed is difficult to distribute and transport • Low variety turnover rate, as any improved varieties meet farmers needs for many years	• Farmers tend to be attached to their own local landraces that suit their specific needs • Seed can be saved and most sorghum seed is produced by the informal sector and is available to farmers through those channels • For OPVs, most new variety development tends to focus on improving existing landraces • Seed is not bulky, but can be moderately perishable
Demand Characteristics *Economic characteristics of the end market for crops that impact the incentives of various players within seed systems*	• Low commercial demand for the crop, as its primary value is in offering food/seed security so farmers are reluctant to invest heavily • Crops are mainly for subsistence or local markets with low quality standards so lower quality seed of local varieties are accepted • Consumers are not discerning about crop traits so varietal performance is not highly valued • No price premium available due to lower-end demand or limited differentiation	• Often grown in areas with marginal growing conditions, so farmers tend to not have high income for purchasing quality seed of improved varieties • Outside of brewing—which mainly uses hybrid sorghum—sorghum does not command a premium in most markets • Crops often grown for on-farm consumption and for household uses such as fuel, animal feed, and building material

Source: Boettiger, Sara et al. "Planning for Scale Brief #1: Tools for Scaling," Ag Partner Exchange, 2013, Figure 2, page 18; Interviews with crop and country experts

Public Sector Dominant Archetype

3 In this archetype, public actors produce EGS and distribute it under subsidized arrangements to advance public goals such as food or seed security

Private	P/P
Niche	**Public**

Value Chain Stages	Ideal State Business Model: Key Actors and Roles	*Illustrative Ideal State: OPV Sorghum*
Variety Research & Development	• ***International research centers (e.g., ICRISAT)*** develop new germplasm that has generally desirable characteristics, sometimes in collaboration with NARS	***International center (e.g., ICRISAT)*** breeds new varieties of disease-resistant sorghum to further bolster food security
Variety Selection & Breeding	• ***Public breeding programs*** select germplasm based on local adaptability and desirability and breed first generation of breeder seed	***NARS (e.g., Tanzania's Department of Research and Development)*** selects varieties and breeds them for adaptation to agro-ecological context
Breeder Seed Production & Maintenance	• ***Public seed producer*** maintains breeder seed on behalf of the public breeding program, as an independent entity from the breeding institute	***Public seed enterprise,*** separate from the breeding program, maintains breeder seed on a regional basis on behalf of the national breeding program
Foundation Seed Production	• ***Public seed producer*** produces foundation seed from breeder seed and distributes it to seed producers on a subsidized basis	***Public seed enterprise*** produces foundation seed for dissemination to seed producers on a subsidized basis
Quality Seed Production	• ***Public seed producer*** manages production of quality seed through subsidized arrangements with outgrowers, farmers organizations or small seed companies	***Public seed enterprise*** produces quality seed through subsidized arrangements with contract growers
Marketing & Distribution	• ***Public seed aggregator*** collects, prices, and promotes demand, and distributes seed, possibly through state apparatus, NGOs, or agro-dealer networks	***Public seed enterprise*** aggregates seed under a subsidized contractual arrangement and distributes it under a subsidized system to farmers

Legend: Type of actor investing in each value chain stage

Private Sector ***Public Sector*** ***Public-Private*** ***IARCs w/ private sector & NARS***

4 A sustained niche occurs when there is a strong but inherently limited demand for a unique seed characteristic

Private	P/P
Niche	Public

	Description	Sustained Niche Example: Hybrid Sorghum for Brewing
Seed Characteristics *Inherent characteristics of the crop and seed's biology and associated agricultural practices that impact the design and viability of seed systems*	• Variety has a unique trait to serve a niche demand • Desirable trait driving niche market demand is not widely demanded for other applications • Seed is profitable only for a limited production	• A specific variety of sorghum is commissioned for a specific beer production, in cases where an existing variety does not possess required traits • Specific variety demanded sometimes does not have wider market demand or applicability • The variety of sorghum will only be valuable until the beer production capacity is met
Demand Characteristics *Economic characteristics of the end market for crops that impact the incentives of various players within seed systems*	• There is strong, but limited demand • Once the limited demand is met, there is no remaining value for the seed • Often a closed market chain, where the end user is funding the production of the seed for exclusive use	• The brewery has limited beer production capacity, and only demands a limited amount of sorghum • Once beer production is at full capacity, there is no additional demand for the sorghum variety (no remaining value for the crop) • Often the beer producer will commission the production of the sorghum variety for their exclusive use

Source: Boettiger, Sara et al. "Planning for Scale Brief #1: Tools for Scaling," Ag Partner Exchange, 2013, Figure 2, page 18; Interviews with crop and country experts

4 A temporary niche can emerge when there is a time-boxed demand for a specific seed characteristic, such as a disease-resistant variety while a disease is rampant

Private	P/P
Niche	Public

	Description	Temporary Niche Example: Sweet Potato
Seed Characteristics *Inherent characteristics of the crop and seed's biology and associated agricultural practices that impact the design and viability of seed systems*	• A certain trait or characteristic is in high demand for a finite amount of time • Production of the trait is limited due to time constraints (cannot meet the demand)	• Disease-prone tuber crops can have temporary high demand depending on current diseases • In times of high disease pressure, existing RTB planting material loses value quickly and must be repurchased frequently • A disease resistant variety will be in high demand only for a limited period of time (while the disease is prevalent)
Demand Characteristics *Economic characteristics of the end market for crops that impact the incentives of various players within seed systems*	• Demand is limited to a specific period of time; after which demand either disappears or becomes stable (moving the seed to the Private-Sector Dominant archetype) • The trait experiences a rapid high spike in demand (demand subsides in the same fashion)	• In time, as the disease subsides, the demand for this variety will either disappear or move to a stable state (moving to the Private –Sector Dominant archetype)

Source: Boettiger, Sara et al. "Planning for Scale Brief #1: Tools for Scaling," Ag Partner Exchange, 2013, Figure 2, page 18; Interviews with crop and country experts

4 In this archetype, few oligopolistic private companies vertically integrate across the value chain, producing EGS and quality seed using a limited number of outgrowers

Private	P/P
Niche	Public

Value Chain Stages	Ideal State Business Model: Key Actors and Roles	*Illustrative Ideal State: Hybrid Sorghum*
Variety Research & Development	• ***Private companies (domestic or MNC)*** lead development of new germplasm that meets market demands in collaboration with ***IARCs*** or ***public breeding programs***	***Private sector*** directs the breeding of new inbred lines to meet requirements for brewing, possibly by providing funding and guidelines to breeders from IARCs, NARS, or universities
Variety Selection & Breeding	• ***Private companies or industry consortia*** select germplasm based on local adaptability and desirability and breed for adapted varieties	***Private companies*** select best inbred lines for their needs and either breed or fund the breeding of adapted varieties for local context
Breeder Seed Production & Maintenance	• ***Private companies or industry consortia*** maintain parent lines and produce subsequent generations of breeder seed	***Private foundation seed enterprise (FSE)*** maintains inbred parent lines and produces breeder seed for companies on an ongoing basis under exclusive variety licenses
Foundation Seed Production	• ***Private companies or industry consortia*** produce foundation seed from breeder seed of varieties either maintained in-house or licensed from another private entity	***Private foundation seed enterprise (FSE)*** produces and markets foundation seed for distribution to private companies under exclusive variety licenses
Quality Seed Production	• ***Private companies*** manage production of quality seed from foundation seed through contractual arrangements with outgrowers	***Private, large domestic companies*** produce quality seed through a narrow network of contract growers and repurchase seed for central processing until throughput is reached
Marketing & Distribution	• ***Private companies*** enter into contractual arrangements with farmers to purchase seed and other inputs and sell produce back to the company for sale	***Private, large domestic companies*** market seed along with other inputs to farmers under contractual repurchase agreements before ultimately marketing produce to breweries

Legend: Type of actor investing in each value chain stage

Private Sector ***Public Sector*** ***Public-Private*** ***IARCs w/ private sector & NARS***

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    - Public Sector Mitigates Demand Risk: ***Sweet Potato in Tanzania, Rice in Nigeria***
    - Public Sector Supports Breeder and Foundation Seed Production: ***Cowpea in Ghana***
  - Public Sector Dominant: ***Sorghum in Ethiopia***
- Government and Donor Recommendations
- Background Research: Country and crop profiles

Market Archetype Business Model Detail

The following business model examples are intended to illustrate the ideal state of each market archetype based on real crop and country conditions, including key enabling factors and specific recommendations for different actors to overcome barriers in the value chain. The examples illustrate the economics of breeder, foundation, and quality seed production with the intention to serve as an analytical tool to identify barriers to scaling production and delivery of early generation seed.

Examples were chosen based on the following criteria:

- **Alignment with the market archetypes:** Country / crop example reflects the seed characteristics and crop demand that is described in each of the market archetypes (e.g., low multiplication rate, demonstrated demand for seed)
- **Closeness to ideal state business model:** Country / crop example already incorporates several elements of the ideal state business model, even if on a small scale (e.g., private sector involved with foundation seed)
- **Donor priority:** Country / crop example represents an investment priority for BMGF and / or USAID
- **Data availability and quality:** Ability to collect high-quality data*

*Note: Zambia was selected for a market visit due to the relative lack of available secondary data as well as its seed sector's alignment with market archetypes

Private Archetype 1 Business Model Example: Hybrid Maize in Zambia

Content:

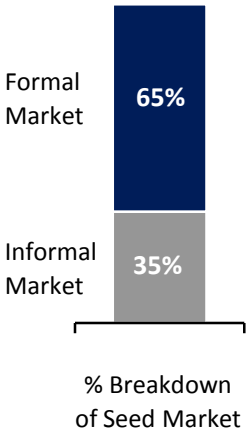
- Background
  - Overview of the sector
  - Existing goals and public / donor efforts to address gaps
  - Current and ideal state of the major actors and their role in the value chain
- Economics of seed production: An overview of the revenue, costs, and margins, as well as required support (if any) to sustain production of the following
  - Breeder Seed
  - Foundation seed
  - Quality seed
- Key enabling factors to support the ideal state
- Barriers and challenges to overcome
- Recommendations

1 The maize market is relatively advanced in Zambia with production exceeding demand in recent years; nevertheless, average maize yields are still below global averages

Private	P/P
Niche	Public

Industry Size and Overview

- Production is higher than domestic demand
- 2014 production estimated at record **3.35 million tons with 1.2M smallholder farmers** producing maize on **1.2M hectares** of land



% Breakdown of Seed Market

- Maize yields in Zambia are around **2 tons per hectare**, well below global averages
- Key industry challenges:
  - Heavy government intervention distorts the market and causes unpredictability in demand
  - Lack of storage facilities
- 11 private companies; top seed companies:
  - **International**: Pannar, Seed Co, Monsanto
  - **National**: Zamseed, Maize Research Institute (MRI)

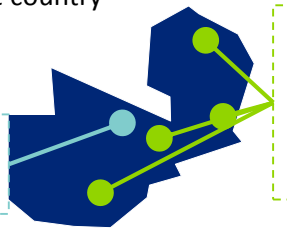
Market

- Smallholder farmers generally buy hybrid maize in 2kg packs due to price and volume needed
- Varieties: **203 varieties** documented in 2010, **mostly hybrid**
  - Most are held by private companies
  - No variety has over 10% of the market
  - New trend of using bio fortified pro-vitamin A maize
  - Radio and health clinics are the main information sources for smallholder farmers on new varieties
- **End uses**: Smallholder farmers and commercial farms
- **Desirable traits:** high yield, provitamin A, drought resistant
- **Crop risks**: common disease, susceptible to drought

Growing Regions

- **Maize is prone to crop failure** due to disease or to weather, as it **requires moderate rainfall**
- Research, breeder, and foundation seed facilities:
  - **Seed Control and Certification Institute** (SCCI) is charged with the seed quality management and certification (inspection, testing, variety release), located in **Chilanga**
  - **Zambia Agricultural Research Institute** (ZARI) coordinates soil and crops research, headquartered in **Chilanga**, with 14 research stations around the country

SCCI and **ZARI** (Chilanga, Lusaka)



Regional Research Stations: Central, Copperbelt, Eastern, Lusaka, Northern and Southern

Programs of BMGF, USAID, and the World Bank

BMGF:

- Drought Tolerant Maize for Africa (DTMA) Project implemented by CIMMYT and IITA seeks to introduce and improve farmer access to drought-tolerant maize varieties in Zambia and elsewhere in SSA
- Fund efforts to biofortify maize with Vitamin A to combat serious nutritional deficiencies, especially among children in Zambia

USAID:

- Feed the Future (FTF) in Zambia has supported policy reforms and worked with smallholder farmers to increase use of hybrid seeds and other inputs and increased productivity 32%
- FTF funds Sustainable Implementation of Maize-Legume Systems for the Eastern Province of Zambia which promotes good agronomic practices and aids introduction and adoption of improved varieties

Sources: UN FAO website, ASTI Private Sector Note and Report; USAID Feed the Future; DTMA, CIMMYT; "Zambia: Orange Maize to Curb Vitamin A Deficiency," IRIN News; theafricareport.com, allafrica.com, HarvestPlus Working Paper, ISSD report, The Changing Structure of the Maize Seed Industry in Zambia: Prospects for Orange Maize

1 The government's agriculture policies involving maize seek to ensure food security, support farmers, and encourage economic growth

Private	P/P
Niche	Public

Government / Donor Priorities	Current Challenges	Existing Investments and Interventions
Food Security	• Maize is a vitally important staple crop, and improved variety adoption is low (e.g. drought resistance); risk of deficit production due to weather, disease, etc. • Government research institutes fear that the private sector will under-invest in improved varieties for nutrition	• Government purchases strategic food reserves through the Food Reserve Agency (FRA), and also markets and distributes surplus • ZARI continues to invest in research and development for varieties with improved micronutrient content (e.g. Vitamin A-rich orange maize), as well as drought and disease resistance
Smallholder Farmer Livelihood	• Only ~55% of seed planted is quality seed of improved varieties, as many rural smallholder farmers lack access due to their distance from producers, low income, and lack of market access for their crop	• FRA provides market access to rural smallholder farmers as part of their mandate to purchase strategic reserves, offering a source of income • Farmer Input Support Program (FISP) subsidizes seed and fertilizer for smallholder farmers • Extension service holds field days, seed fairs, and forums to educate farmers and solicit input
Economic Growth and Stability	• GDP has suffered from a decrease in the price of copper, which has dominated Zambian exports, creating a need to diversify	• Government is active in trade policy, adjusting import and export policies based on domestic production and ability to meet demand

Sources: Zambia's Exports are Growing and Diversifying, but They Could Do Better, World Bank; Zambia: Poor FRA Maize Marketing a Blow to Agric Sector, AllAfrica.com; Expert Interviews

Private	P/P
Niche	Public

1 Currently, the private sector is involved in nearly all stages of the seed value chain with the public sector playing a role in breeder seed production and marketing efforts

Variety Research & Development	Variety Selection & Breeding	Breeder Seed Production & Maintenance	Foundation Seed Production	Quality Seed Production	Marketing & Distribution
Current State					
1. CIMMYT (CGIAR) • Develops new varieties through public and donor-funded programs, e.g., Drought Tolerant Maize for Africa (DTMA) funded by BMGF and USAID, which are licensed to NARS or private companies for royalties • Location: HQ in Mexico City ***2. Private Seed Companies*** • Large local seed companies such as Zamseed and Seed Co, and MNCs like Monsanto and Syngenta conduct research and breeding, sometimes with CIMMYT or public germplasm • Locations: Lusaka (Zamseed, Seed Co), US and Europe ***3. Zambian Agricultural Research Institute (ZARI)*** • National public research institute, which produces breeder seed for sale to local companies • Location: Lusaka	***1. Private Seed Companies*** • Most breeding occurs in private companies' research labs, conducted by in-house breeders to produce new inbred lines and hybrids from public and international germplasm ***2. Zambian Agricultural Research Institute (ZARI)*** • ZARI conducts breeding with public funding, often for varieties with improved nutritional content or resistance to drought or disease	***1. Private Seed Companies*** • Private companies conduct their own maintenance breeding and breeder seed production ***2. Zambian Agricultural Research Institute (ZARI)*** • ZARI maintains parent lines and produces breeder seed which it licenses to private companies, on either an exclusive or non-exclusive basis, and receives small royalties that are not intended to fully recoup costs	***1. Private Seed Companies*** • Private companies produce foundation seed using proprietary or publicly licensed breeder seed	***1. Private Seed Companies*** • Private companies produce some quality seed on their plots, but mostly through contract growers, by supplying foundation seed on credit and repurchasing quality seed for processing	***1. Private Seed Companies*** • Private companies market and distribute their quality seed through agents and agro-dealers to smallholder and commercial farmers ***2. Government*** • Government extension services distribute seed to rural smallholder farmers at seed fairs and field days, during which time they also provide education and training on proper agronomic practices for the seed

Legend: Type of actor investing in each value chain stage

Private Sector ***Public Sector*** ***Public-Private*** ***IARCs w/ private sector & NARS***

Source: Expert Interviews

1 Given the demand and profitability of maize seed, in the ideal state, the private sector should dominate nearly all stages of the value chain

Private	P/P
Niche	Public

Variety Research & Development	Variety Selection & Breeding	Breeder Seed Production & Maintenance	Foundation Seed Production	Quality Seed Production	Marketing & Distribution

Ideal State

1. CIMMYT (CGIAR)
- Develops new varieties through public and donor-funded programs, e.g., Drought Tolerant Maize for Africa (DTMA) funded by BMGF and USAID, which are licensed to NARS or private companies for royalties
- Location: HQ in Mexico City

2. Private Seed Companies
- Large local seed companies such as Zamseed and Seed Co and MNCs like Monsanto and Syngenta conduct research and breeding, sometimes with CIMMYT or public germplasm
- Locations: Lusaka (Zamseed, Seed Co), US and Europe

3. Zambian Agricultural Research Institute (ZARI)
- National public research institute, mainly serves a facilitating role between CIMMYT and private companies
- Location: Lusaka

1. Private Seed Companies
- All in-country breeding of varieties for adaptation to local context introduction occurs in private companies' research labs, conducted by in-house breeders to produce new inbred lines and hybrids from public and international germplasm

2. Zambian Agricultural Research Institute (ZARI)
- ZARI serves mainly a facilitating role with the private sector increasingly bearing the costs of breeding

1. Private Seed Companies
- Private companies conduct their own maintenance breeding and breeder seed production

2. Zambian Agricultural Research Institute (ZARI)
- ZARI serves mainly a facilitating role with the private sector increasingly bearing the costs of breeder seed production and parent line maintenance

Ideal State: ZARI should reduce investment in R&D, breeder seed production, and parent line maintenance for hybrid maize to focus on crops that do not attract as much private sector investment, and serve primarily as a facilitator between private companies and CIMMYT, with the private sector increasingly bearing the cost of those activities

1. Private Seed Companies
- Private companies produce foundation seed using proprietary or publicly licensed breeder seed

1. Private Seed Companies
- Private companies produce quality seed in small part on their plots and mostly through contract growers, by supplying foundation seed on credit and repurchasing quality seed for processing

1. Private Seed Companies
- Private companies market and distribute their quality seed through agents and agro-dealers to smallholder and commercial farmers

2. Government
- Government extension services focus on conservation agriculture for hybrid maize and shift most investment to less profitable crops

Ideal State: Government redirects most extension services to less profitable crops and focus on hybrid maize as it pertains to conservation agriculture, as private companies' distribution networks improve and smallholder farmers' purchasing power increases with greater market access

Legend: Type of actor investing in each value chain stage

Private Sector | *Public Sector* | *Public-Private* | *IARCs w/ private sector & NARS*

Source: Expert Interviews, Monitor Deloitte Analysis

Private	P/P
Niche	Public

1 High profitability of quality seed production enables backwards integration by private companies into early generation seed production while still earning a strong return

Breeder Seed – 100 kg		Key Observations and Insights *(see Appendix for detailed costs and assumptions)*
Variable Cost	$105,584 (13%)	Fixed costs are very high for breeder seed due to capital investment in lab space and equipment as well as salaries for highly skilled breeders and labor, while variable costs are low and are dominated by germplasm royalties paid to research centers
Fixed Cost	$688,774 (87%)	
Total Breeder Seed Cost	$794,358	Breeding and breeder seed production and maintenance are very costly activities that are not profitable on their own, due to the very low volume produced, but companies may find value investing in controlling this part of their value chain

Foundation Seed – 3 MT		
Variable Cost	$21,417 (5%)	Foundation seed has high fixed costs due to the need for skilled labor for hybridization and processing equipment, while variable costs are very low due to low volume and low transport costs due to low bulk and perishability
Fixed Cost	$422,882 (95%)	
Total Foundation Seed Cost	$444,299	Similar to breeder seed, foundation seed costs are high relative to the volume produced and would not be profitable as a standalone enterprise unless very large scale could be achieved

Quality Seed – 1,000 MT		
Variable Cost	$827,285 (67%)	Fixed costs are low for quality seed and consist mainly of equipment, while per-unit variable costs are low due to high multiplication rates and low transport costs (low bulk and perishability), so it can be profitable even at relatively small scale
Fixed Cost	$413,642 (33%)	
Total Quality Seed Cost	$1,240,927	Total costs for quality seed production are high due to large volume, so it is produced by large companies with access to credit or by contract growers to whom the company extends credit

Total Quality Seed Revenue	$3,500,000	At a price of $3,500/MT, quality seed sales are profitable enough that private companies can vertically integrate into the upstream stages of the value chain that are not profitable as standalone businesses and still earn an acceptable return
Total Cost of Production	$2,479,584	
Total Profit	$1,020,416	
Profit Margin (%)	29%	

Despite the high costs for human and physical capital required for early generation seed, quality hybrid maize seed is profitable enough that the entire value chain can be profitable for a vertically integrated company to manage end-to-end, as domestic companies like Zamseed and MNCs like Syngenta do now

Notes:
(1) Costs represent one variety since producing several varieties is only marginally more costly. Additional costs that may be incurred would come out in management, labor, and land costs.
(2) Costs represent a typical seed producer's cost to produce seed of market-standard quality at the time it is demanded, though this could pose a greater challenge for some producers versus others
(3) "Breeder Seed" includes both the production of breeder seed (technology commercialization) and the R&D, variety selection and breeding efforts required to develop new varieties

Private	P/P
Niche	Public

1 In an ideal state, several enabling factors can help ensure successful private investment in the hybrid maize seed value chain and ensure sustainable, consistent profitability

Policy / Regulatory	**Conducive Policy & Regulatory Framework**	• No EGS production restrictions • IP protections exist and are enforced • Regulation is stable and predictable	• Consistent and liberal trade policy • International harmonization (e.g. COMESA)
Value Chain Capacity	**Technical & Management Capabilities**	• Sufficiently educated workforce exists • Training programs are adequate for required technical proficiency	• Managers have foundational business skills • Actors in the sector understand domestic and international market dynamics
	Market Linkages & Data Availability	• Sufficient linkages exist to understand upstream supply and downstream demand and evaluate risk and potential upside	• Market data allows actors to measure performance against competitors
Seed Market	**Sufficient Demand**	• Consumer willingness to pay is greater than production cost • Demand is stable and predictable	• Improved varieties offer desirable traits and command a price premium
Quality Assurance	**Reliable Quality Assurance Mechanism**	• Quality assurance processes exist and are consistently enforced • Mechanism is credible and trusted	• Costs should not be prohibitive for enforcement or compliance • Variety release process is expedient
Supporting Environment	**Access to Sufficient Land & Infrastructure**	• Land rights regime allows sufficient access to productive land	• Physical infrastructure supports production and distribution (roads, irrigation, storage)
	Access to Capital and Financing	• Access to financing and low interest loans to fund working capital and capital investments in facilities, equipment, etc.	• Farmer access to loans and financing to purchase planting material and inputs • Tools for risk mitigation (e.g., insurance)

Source: Expert Interviews, Monitor Deloitte Analysis

Private	P/P
Niche	Public

1

Nevertheless barriers exist that need to be addressed

Policy / Regulatory	**Conducive Policy & Regulatory Framework**	• Trade policy is inconsistent and results in restricted and unpredictable export market • FRA distorts prices by buying more grain than is needed for strategic reserves, paying non-market prices, and sometimes distorting international markets by exporting surplus
Value Chain Capacity	**Technical & Management Capabilities**	• Limited supply of breeders makes cost of employing breeders very high • Farmers do not realize full benefits of quality seed of improved varieties due to lack of knowledge of required agronomic practices
	Market Linkages & Data Availability	• Smallholder farmer market is highly dispersed and difficult for companies to reach for distribution
Seed Market	**Sufficient Demand**	• Input subsidies, e.g. FISP, introduce uncertainty into the market and may distort demand
Quality Assurance	**Reliable Quality Assurance Mechanism**	• Limited ongoing training and monitoring of field inspectors after initial licensing
Supporting Environment	**Access to Sufficient Land & Infrastructure**	• Dispersed availability of land results in long distances between breeding / foundation seed sites and contract growers who produce quality seed, increasing transportation costs
	Access to Capital and Financing	• Small amounts of working capital financing are available, e.g. selling seed to contract growers on credit, but larger loans for capital expenditures are extremely expensive (>20%), e.g. for heavy equipment

Source: Expert Interviews, Monitor Deloitte Analysis

Private	P/P
Niche	Public

1 Government and donors can play a role in addressing and overcoming these barriers

			Lead Actor and Role
Policy / Regulatory	**Conducive Policy & Regulatory Framework**	• Remove export restrictions and work toward harmonization • Gradually scale FRA back down to strategic reserve level and/or replace reserves with commodities trading instruments	• Gov. of Zambia, policy • Gov. of Zambia, policy
Value Chain Capacity	**Technical & Management Capabilities**	• International ag. education exchange programs and fellowships • Incentivize seed companies to train farmers in the proper use of their seed, associated agronomic practices, etc.	• BMGF; funding, liaison • Gov. of Zambia, policy
	Market Linkages & Data Availability	• Develop business case to demonstrate and evaluate profit potential of widening distribution networks • Test innovative solution prototypes for increasing profitability, e.g. mobile-based seed ordering to aid in distribution planning	• BMGF; funding
Seed Market	**Sufficient Demand**	• Link input subsidy eligibility to productivity gains	• Gov. of Zambia, policy
Quality Assurance	**Reliable Quality Assurance Mechanism**	• Implement annual "refresher" training and assessment, potentially online or mobile-based	• Gov. of Zambia, program development
Supporting Environment	**Access to Sufficient Land & Infrastructure**	• Develop business case for decentralized private processing facilities, potentially through a consortium of private companies	• BMGF, funding
	Access to Capital and Financing	• Explore options for government support to financial sector to help banks gain experience in the ag sector and become sustainable, e.g. loan guarantees, portfolio requirements	• World Bank and Gov. of Zambia, funding

Source: Expert Interviews, Monitor Deloitte Analysis

Private	P/P
Niche	Public

1

Conclusion and Implications for Market Archetype 1

Reflections on Hybrid Maize in Zambia:

- Despite distribution challenges and policy uncertainty, Hybrid Maize in Zambia has attracted private sector investment by removing restrictions on seed production and facilitating private sector activity through efficient, responsive regulation
- Because of its geographic location, Zambia can be a regional producer of hybrid maize, with high potential for growth with improvements to the overall enabling environment
- Private sector seed production is vibrant and supported by an efficient regulatory body (SCCI), and private companies often have in-house breeding programs, supported by germplasm sourced from public and international institutes (ZARI, CIMMYT)
- Government maize policy in Zambia is unpredictable and distortionary, including subsidies, import/export bans, and food reserve purchasing, which is introducing more risk in the sector, and discouraging increased private investment
- Smallholder farmers often live in remote, rural areas and have limited access to quality seed of improved varieties and the agronomic knowledge required to reap their benefits

Overall Implications for Market Archetype 1 Seed Sectors:

- Even in vibrant private markets (e.g., hybrid maize in Nigeria and Ghana), international research centers will play a role in research in the near term due to the technical capacity required and scarcity of local human capital; parent line maintenance can and should be the role of the private sector
- Distortions in end markets for crops—due to trade restrictions, subsidies, etc.—can spill over into seed markets and introduce risks to private seed producers
- Private investment in seed may not be sufficient to translate benefits to rural smallholder farmers, and the public sector can incentivize companies to increase their social impact, e.g. widening distribution networks, decentralizing operations, or training farmers on seed

Archetype 1 Key Takeaway: *While Archetype 1 crops are naturally attractive to private actors, the public sector has a key role to play in ensuring crop markets function efficiently and the benefits of investment spill over to underserved regions, markets, and demographics*

Public-Private Archetype 2a Business Model Example: Sweet Potato in Tanzania

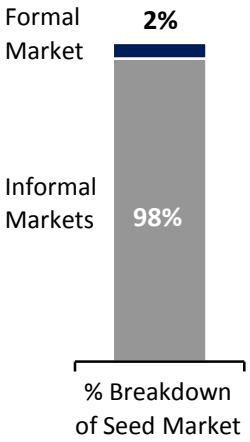
Content:

- Background
  - Overview of the sector
  - Existing goals and public / donor efforts to address gaps
  - Current and ideal state of the major actors and their role in the value chain
- Economics of seed production: An overview of the revenue, costs, and margins, as well as required support (if any) to sustain production of the following
  - Breeder Seed
  - Foundation seed
  - Quality seed
- Key enabling factors to support the ideal state
- Barriers and challenges to overcome
- Recommendations

2a The sweet potato market in Tanzania is dominated by the informal sector; demand for quality planting materials of improved varieties is low and inconsistent

Private	P/P
Niche	Public

Industry Size and Overview



- Annual country-wide production of **2.4 million MT** on **576K ha of planted land**
  - Productivity is at **4.2 MT/ha** vs. potential yields of 20-40 MT/ha
  - Currently no import or export of sweet potatoes
- Household consumption of **1,381,120 MT**
- **12 improved varieties** released between 2000-2013 (all SVPD-resistant, 5 OFSP)
- Only **1.7%** of the area planted is planted with improved varieties (as of 2008)
- Seed data is limited due to the dominance of the informal sector

Growing Regions

- Sweet potato can grow under **marginal conditions**, and **matures quickly** with **flexible planting and harvest** times
- Sweet potato is grown **throughout the country**, but is most concentrated in the **Lake Zone** near Lake Victoria (little growth in Central Zone)
- **Agricultural Research Institutes** (ARIs) under the DRD:
  - **Lake Zone:** Ukiriguru, Maruku
  - **Eastern Zone:** Ilonga, Kibaha (Sugarcane Research Institute), Mikocheni
  - **Southern Highlands Zone**: Uyole

Top growing region: **Lake Zone**

Market

- Main **end-use is consumption** as a snack, often boiled, though it is roasted or fried in some areas, like Dar es Salaam
  - **Very little processing of sweet potato for end use,** though it is being promoted for use in baking and confection
- Consumers rarely consider micro-nutrition, but purchase based on:
  - **Appearance:** skin/flesh color (*not* orange-fleshed) root size
  - **Consumption:** low fiber, high starch/DMC, taste, cook time
  - **Economics:** storability, price
- **Crop risks include:**
  - Pests (e.g., weevil), and disease (e.g., SPVD)
  - Lack of suitable land and inputs
  - Unavailable quality planting material of improved varieties

Programs of BMGF, USAID, and the World Bank

BMGF:

- Many programs to support vine multiplication and dissemination, including: Marando Bora SASHA (I and II), Distributed Vine Multiplication Project, Reaching Agents of Change, Kinga Marando, SeFaMaCo, and Commercialisation of Sweetpotato Vine Multipliers
- Promote OFSP in schools (Fasttrack) and on radio (Farm Radio Intl.)
- Funding sweet potato R&D at NC State University with $12.4 M

USAID is investing in clean seed production through programs such as the five-year Tanzania Agricultural Productivity Program (TAPP)

World Bank committed $55M in 2012 to fund the timely delivery of seeds and fertilizer and improve access to equipment and knowledge and have VISTA project to support vine multiplication/dissemination

Multiple Donors are helping R&D actors interact with each other (ASARECA-AIS) and promoting OFSP for nutrition (DONATA)

Sources: SeFaMaCo Landscape Analysis Report; Landscaping for ISSD Tanzania Final; Why Invest in Orange-fleshed Sweet potato in Tanzania?, SweetPotatoKnowledge.org; UN FAO Website, Seeds and Agricultural Research Processes in Tanzania, European Commission; "NCSU gets $12.4M from Gates," NewsObserver.com; "Boost for Tanzania Agriculture Sector," World Bank\

2a Government and donors are seeking to increase uptake of drought resistant and orange-fleshed varieties of sweet potato to ensure food security and improve nutrition

Private	P/P
Niche	Public

Government / Donor Priorities	Current Challenges	Existing Investments and Interventions
Food Security and Smallholder Farmer Livelihoods	• Low profitability of sweet potatoes **limits the amount farmers plant** • Sweet potato has a **low reputation** as a "poor person's" crop, which has contributed to **low planted area** • Furthermore, uptake and demand for quality planting materials is low since farmers can replant year over year, making the **crop more vulnerable to drought and disease**	• The government is developing a national certification process for sweet potato inputs to **improve farmer trust in quality seed of improved varieties and increase demand in the formal seed sector** • The Bill and Melinda Gates Foundation is partnering with research institutes to improve the breeding techniques and quality of varieties released to **decrease the cost and improve the quality of seed** with the goal to increase the demand for clean planting materials
Nutrition	• Although the orange-fleshed varieties of sweet potato (OFSP) have a higher nutritional value, **consumer demand for these varieties is low**, and therefore farmers are not demanding or planting these varieties	• The Ministry of Health and Social Welfare and Ministry of Agriculture, Food Security, and Cooperatives have developed an **advocacy and communication strategy** to promote stakeholder investment in production and utilization of OFSP and to **create demand** among farmers and consumers

Source: "Why Invest in OFSP in Tanzania?" SweetPotatoKnowledge.org; Expert Interviews

2a Currently, the public sector is involved in all stages of the formal value chain; where private players do exist, public research institutes play an intermediary role

Private	P/P
Niche	Public

Variety Research & Development	Variety Selection & Breeding	Breeder Seed Production & Maintenance	Foundation Seed Production	Quality Seed Production	Marketing & Distribution

Current State

1. International Potato Center (CIP)

- CIP has sweet-potato breeding support platforms at the sub-regional level and works closely with national program breeders to develop and release varieties with strong farmer and consumer demand
- Location: Nairobi

2. National Agricultural Research System (NARS)

- National research system collaborates with other institutes (i.e. CIP, NaCRRI) on research and development of varieties adapted to local conditions
- Locations: Six regional Agricultural Research Institutes (ARIs) in Tanzania

3. National Crops Resources Research Institute (NaCRRI),

- Uganda-based research institution that collaborates with other research institutes (i.e. CIP, NARS) to develop improved varieties

1. National Agricultural Research System (NARS)

- Collaborates with regional research institutions (i.e. NaCRRI) on research and development of new varieties that are adapted to local conditions

2. National Crops Resources Research Institute (NaCRRI),

- Collaborates with other international research institutes (i.e. IITA) to breed new varieties adapted to regional conditions

1. National Agricultural Research System (NARS)

- Produces breeder seed and of approved varieties that are adapted to local conditions, and may maintain populations of parental material for these varieties in collaboration with other institutes

2. National Crops Resources Research Institute (NaCRRI),

- Produces breeder seed for local use (Uganda) sells breeder seed to other regional government and agricultural institutions (i.e. NARS), and may maintain populations of parental material for these varieties in collaboration with other institutes

1. National Agricultural Research System (NARS)

- Multiplies breeder seed into foundation seed via tissue culture labs or decentralized vine multipliers, including any generations of basic seed that are required for multiplication
- Distributes clean planting materials regionally to sell or give to quality seed producers
- Mostly project-based with no consistent or sustainable funding mechanism at present (under development through SASHA II)

2. Tissue Culture Labs

- Hired by NARS to centrally multiply breeder seed in a controlled setting, including any generations of basic seed that are required for multiplication
- NARS provides breeder seed inputs and repurchases the multiplied foundation seed to distribute regionally to quality seed growers

1. National Agricultural Research System (NARS)

- Repurchases foundation seed from contracted tissue culture labs to distribute to decentralized, regional vine multipliers for quality seed production

2. Contract Growers

- Foundation seed is given or sold to decentralized vine multipliers to multiply seed into quality seed for sale or distribution to farmers

1. NGOs and Local Governments

- NGOs and local governments purchase quality seed for sale or distribution to regional and smallholder farmers for local production and consumption

2. Contract Growers

- Regional vine multipliers sell quality seed to local smallholder farmers, or produce sweet potato for local production and consumption

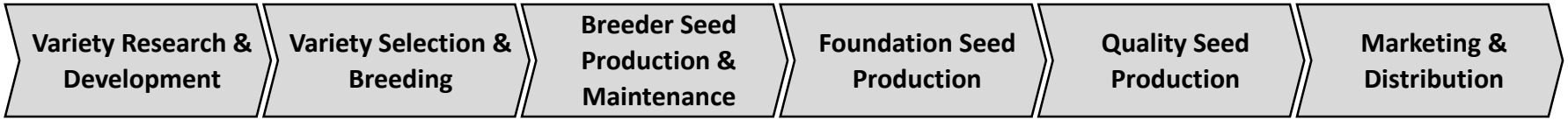
Legend: Type of actor investing in each value chain stage

Private Sector ***Public Sector*** ***Public-Private*** ***IARCs w/ private sector & NARS***

Source: Expert Interviews

2a In the ideal state, the private sector would be involved in foundation and quality seed production without the NARS playing an intermediary role

Private	P/P
Niche	Public



1. International Potato Center (CIP)

- CIP partners with other research centers around the world to develop improved varieties (i.e. North Carolina State University, Michigan University, etc.)
- Location: Nairobi

2. National Agricultural Research System (NARS)

- Nationally funded research system that collaborates with other international research institutes (i.e. IITA, CIP, NaCRRI) on research and development of locally adapted varieties
- Locations: Six regional Agricultural Research Institutes (ARIs) in Tanzania

3. National Crops Resources Research Institute (NaCRRI),

- Uganda-based research institution that collaborates with other international research institutes (i.e. IITA, CIP, NARS) to develop improved varieties

1. National Agricultural Research System (NARS)

- Collaborates with regional research institutions (i.e. NaCRRI) on research and development of locally adapted new varieties

2. National Crops Resources Research Institute (NaCRRI),

- Collaborates with other international research institutes (i.e. IITA) to breed new regional varieties

1. National Agricultural Research System (NARS)

- Collaborates with private tissue culture labs to produce and maintain breeder seed

2. National Crops Resources Research Institute (NaCRRI),

- Produces breeder seed for local use (Uganda) sells breeder seed to other regional government and agricultural institutions (i.e. NARS)

Ideal State: Private tissue culture labs collaborate with NARS to produce and maintain breeder seed

1. National Agricultural Research System (NARS)

- Multiplies breeder seed into foundation seed via tissue culture labs or decentralized vine multipliers, including any generations of basic seed that are required for multiplication
- Distributes clean planting materials regionally to sell or give to quality seed producers

2. Tissue Culture Labs

- Produce foundation seed of public varieties, including any generations of basic seed that are required for multiplication, using breeder seed maintained jointly with NARS, ultimately for sale to growers to produce quality seed for

1. National Agricultural Research System (NARS)

- Repurchases foundation seed from contracted tissue culture labs to distribute to decentralized, regional vine multipliers for quality seed production

2. Contract Growers

- Foundation seed is sold to decentralized vine multipliers to multiply seed into quality seed for sale or distribution to farmers

Ideal State: Private tissue culture labs or multipliers receive breeder seed inputs and privately produce foundation seed, selling directly to quality seed producers or contract growers for quality seed production

1. Public Extension Service

- Public extension service, possibly managed by local or regional governments, purchase quality seed for sale or distribution to regional and smallholder farmers for local production and consumption

2. Contract Growers

- Regional vine multipliers sell quality seed to local smallholder farmers, or produce sweet potato for local production and consumption

Legend: Type of actor investing in each value chain stage

Private Sector ***Public Sector*** ***Public-Private*** ***IARCs w/ private sector & NARS***

Source: Expert Interviews, Monitor Deloitte Analysis

2a Foundation and quality seed production can be profitable if demand is stable and predictable

Private	P/P
Niche	Public

Breeder Seed		Key Observations and Insights *(see Appendix for detailed costs and assumptions)*
Variable Cost	$1,800 (16%)	Fixed labor is the largest cost driver for breeder seed
Fixed Cost	$9,750 (84%)	
Total Breeder Seed Cost	$11,550	
Total Profit	($11,550)	Breeder seed production is expensive due to the technical labor and training needed. Currently no revenue is collected for breeder seed, making this stage of the value chain largely unprofitable, though the value chain could support the cost of breeder seed inputs
Profit Margin (%)	N/A	

Foundation Seed – 50 acres		
Variable Cost	$3,350 (20%)	Labor and training are the largest cost drivers for foundation seed production, but limited input costs (and no cost for breeder seed inputs) keep this stage profitable
Fixed Cost	$13,150 (80%)	
Total Foundation Seed Cost	$16,500	
Total Profit	$17,340	High disease and perishability could affect sales of foundation seed
Profit Margin (%)	51%	

Quality Seed – 1000 acres		
Variable Cost	$169,110 (69%)	Labor and irrigation equipment are the largest costs of quality seed production, though low land costs keep the value chain profitable if demand is sustainable
Fixed Cost	$75,000 (31%)	
Total Quality Seed Cost	$244,110	
Total Quality Seed Revenue	$507,600	
Total Profit	$263,490	High perishability and unstable demand add risk to an otherwise profitable value chain
Profit Margin (%)	52%	

The sweet potato value chain can be profitable, however, unstable demand and high susceptibility to disease and perishability add risk to the value chain

Notes:
(1) Costs represent one variety since producing several varieties is only marginally more costly. Additional costs that may be incurred would come out in management, labor, and land costs.
(2) Costs represent a typical seed producer's cost to produce seed of market-standard quality at the time it is demanded, though this could pose a greater challenge for some producers versus others
(3) "Breeder Seed" includes both the production of breeder seed (technology commercialization) and the R&D, variety selection and breeding efforts required to develop new varieties

2a In an ideal state, several enabling factors can help increase efficiency in the sweet potato seed value chain and ensure scale

Private	P/P
Niche	Public

Policy / Regulatory	**Conducive Policy & Regulatory Framework**	• No EGS production restrictions • IP protections exist and are enforced • Regulation is stable and predictable	• No policies that discourage private entry into the sector (e.g. excessive tax)
Value Chain Capacity	**Technical & Management Capabilities**	• Sufficiently educated workforce exists • Training programs are adequate for required technical proficiency	• Managers have foundational business skills and knowledge (i.e., book keeping, accounting)
	Market Linkages & Data Availability	• Sufficient linkages exist to understand upstream supply and downstream demand and evaluate risk and potential upside	• Market data allows actors to measure performance against competitors
Seed Market	**Sufficient Demand**	• Consumer or government willingness to pay is greater than production cost • Demand is stable and predictable	• Improved varieties offer desirable traits and command a price premium
Quality Assurance	**Reliable Quality Assurance Mechanism**	• Quality assurance processes exist and are consistently enforced • QA mechanism is credible and trusted	• Costs should not be prohibitive for enforcement or compliance • Variety release process is expedient
Supporting Environment	**Access to Sufficient Land & Infrastructure**	• Land rights regime allows sufficient access to productive land	• Physical infrastructure supports production and distribution (roads, irrigation, storage)
	Access to Capital and Financing	• Low interest access to financing and loans to fund working capital and capital investments in facilities, equipment, etc.	• Farmer access to loans and financing to purchase planting material and inputs • Tools for risk mitigation (e.g., insurance)

Source: Expert Interviews, Monitor Deloitte Analysis

Private	P/P
Niche	Public

2a

Nevertheless barriers exist that need to be addressed

Policy / Regulatory	**Conducive Policy & Regulatory Framework**	• Historical restriction on EGS production by private sector restricted investment until the Seed Act of 2003 • Donor funding is project-based and short-term, which doesn't catalyze long-term change
Value Chain Capacity	**Technical & Management Capabilities**	• Limited interest in research and agriculture as a career path limits human capital capacity • Limited resources for training of researchers, breeders, and growers limits human capital
	Market Linkages & Data Availability	• Little data exists on costs and potential opportunities within the seed value chain, including demand for varieties in informal seed systems • Breeding efforts are not linked to farmer demand due to focus on "pushing" OFSP
Seed Market	**Sufficient Demand**	• Farmer demand is inconsistent due to weather and price fluctuations affecting substitutes • Low end-market margins keep seed demand and prices relatively low
Quality Assurance	**Reliable Quality Assurance Mechanism**	• Historical lack of quality assurance has reduced farmers willingness to pay for seed from the formal sectors, due to risk that claimed benefits are not present
Supporting Environment	**Access to Sufficient Land & Infrastructure**	• Lab and storage facilities are generally not state-of-the-art and / or well-maintained
	Access to Capital and Financing	• Lack of affordable financing available to SME seed companies due to lack of good financial information from companies and lack of agricultural risk assessment capacity at banks • Banking sector lacks capacity to meet financing needs

Source: Expert Interviews, Monitor Deloitte Analysis

Private	P/P
Niche	Public

2a Government and donors can play a role in addressing and overcoming these barriers

			Lead Actor and Role
Policy / Regulatory	**Conducive Policy & Regulatory Framework**	• Officially modify and implement policy opening EGS sector • Develop business case studies as proof-of-concept for private seed companies	• Gov. of Tanzania, policy • USAID, funding source
Value Chain Capacity	**Technical & Management Capabilities**	• International ag. education exchange programs and fellowships • Training for operational data collection and bookkeeping	• BMGF; funding, liaison • USAID / BMGF; funding, program development
	Market Linkages & Data Availability	• Deepen trend analysis for demand forecasting for breeding • Analyze demand for varieties in informal seed systems • Aggregation service for market data on demand, prices, etc.	• World Bank, funding • BMGF, funding until self-funded
Seed Market	**Sufficient Demand**	• Guarantee consistent demand through purchase of surplus • Promote higher-value commercial uses of the end crop to increase price premium and margins	• Gov. of Tanzania, funding • BMGF and Government
Quality Assurance	**Reliable Quality Assurance Mechanism**	• Implement sustainable quality assurance process for RTB crops, such as certification, accreditation/authorization, or truth-in-labeling	• BMGF, funding source
Supporting Environment	**Access to Sufficient Land & Infrastructure**	• Some form of subsidy (e.g. tax exemption) for providers/owners of lab and storage equipment and facilities	• Gov. of Tanzania, policy
	Access to Capital and Financing	• Government-backed bank loans and portfolio requirements for agriculture financing to increase loans in the sector • Microfinance to stimulate demand among smallholder farmers	• Gov. of Tanzania, funding • Gov. of Tanzania, policy • World Bank, liaison

Source: Expert Interviews, Monitor Deloitte Analysis

Public-Private Archetype 2a Business Model Example: Rice in Nigeria

Content:

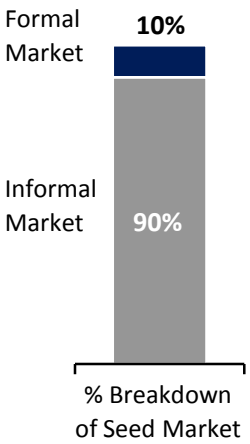
- Background
  - Overview of the sector
  - Existing goals and public / donor efforts to address gaps
  - Current and ideal state of the major actors and their role in the value chain
- Economics of seed production: An overview of the revenue, costs, and margins, as well as required support (if any) to sustain production of the following
  - Breeder Seed
  - Foundation seed
  - Quality seed
- Key enabling factors to support the ideal state
- Barriers and challenges to overcome
- Recommendations
- Examples of other country and crop contexts in Market Archetype 2a

2a Rice in Nigeria is the most consumed staple food in Nigeria; demand outpaces supply due to low production yields and lack of processing capacity

Private	P/P
Niche	Public

Industry Size and Overview

- Production lags behind consumption, necessitating grain imports
  - Average annual production of **2.64 million MT of rice grain** on **2.3M ha of land** (2011-14)
  - Average annual consumption of **5.75 million MT** (2011-14)



- The Nigerian government has focused on **growing domestic rice production**
- **Capacity issues and gaps in processing** have historically been the biggest bottleneck to increasing rice supply
- Research and development of new varieties is largely driven by the **public sector**
- **65% of production occurs in lowland rainfed areas**, but only 37% of those areas use improved varieties
- Since the mid-1980s, **most improved varieties have been released for upland ecologies**, which only account for 27% of production

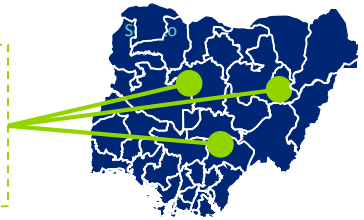
Market

- Main **end-use is consumption** as a staple
  - **Processing involves parboiling and milling**, and is usually conducted away from the farm by co-operatives
- Desirable seed traits include **early maturity, high yield, resistance to pests/diseases, long grains**
- **Crop risks include:**
  - Lack of irrigated land
  - Diseases (e.g. rice blast), pests (e.g. stem borers, weaverbirds), and weeds (often in upland rice)
  - Difficulty and cost of land preparation

Growing Regions

- Growing rice seed is **labor intensive** and **requires large amounts of water** through flooding, rainfall, or irrigation
- Rice is primarily grown in the lowland rainfed areas around the Niger River drainage system
- **Research, breeder, and foundation seed facilities**:
  - **National Cereals Research Institute** (NCRI)
    - Institute dedicated to genetic improvement and production of stable grains, with 10 outstations throughout Nigeria
  - **AfricaRice** (formerly WARDA)
    - Pan-African research organization with a station in Oyo, Nigeria
  - **International Institute of Tropical Agriculture** (IITA)

Top growing regions (by hectares used for rice production): Kaduna, Benue, Gombe, Kebbi, Enugu



Programs of BMGF, USAID, and the World Bank

BMGF:

- Collaborating with smallholder farmers and conducting R&D to improve productivity of rice production

USAID:

- In 2013, partnered with the Central Bank and Ministry of Agriculture to leverage $100M in commercial lending to local agribusinesses
- MARKETS II provides access to inputs, finance, and capacity-building

World Bank:

- Approved $300M in loans for smallholder farmers producing staples, and for improvement of crop yields and market access

Sources: IFPRI Discussion Paper 01343—Importance of Rice Research and Development in Rice Seed Policies; USDA stats from IndexMundi.com; National Rice Development Strategy, Nigeria, 2009; Multi-agency Partnerships for Technical Change in West African Agriculture, ODI; Nigeria: World Bank Approves US $300 Million Loan for Agriculture in Nigeria, AllAfrica.com; USAID and Nigerian Government Partner to Increase Private Financing for Nigerian Agriculture, USAID.gov; Nigeria MARKETS II, USAID

2a The government has set a goal to become self-sufficient in domestic rice production; the country is still far off from meeting this goal

Private	P/P
Niche	Public

Government / Donor Priorities

Achieve Self-Sufficiency and Begin Exporting Domestic Rice Production

Current Challenges

- Nigeria's goal has been to **become self-sufficient by 2015** and increase domestic rice production to 12.85 million MT by 2018
- However, domestic demand has continued to outstrip supply, making Nigeria the **2nd largest importer of rice in the world**
- Historically, **major gaps and capacity issues in post-harvest processing** acted as the main bottleneck for rice production
- **Lack of irrigation and appropriate seed development** also harm the rice production value chain

Existing Investments and Interventions

- In 2009, Nigeria developed a National Rice Development Strategy focused on 1) Improving post-harvest handling and **processing**, 2) Increasing **land development**, irrigation development, and paddy production, and 3) improving **seed and production input development**
- In recent years, Nigeria has used trade policy reforms to discourage rice smuggling and importation, and **encourage investment in domestic rice production via import tariffs**
- Donors like the Gates Foundation, USAID, and World Bank have focused on **improving agricultural productivity, improving market access, and improving capital access**

Sources: "Nigeria to Export Rice in 4 Years," The Cable Nigeria; Expert Interviews

2a The public sector is involved with nearly all parts of the value chain, with private companies producing quality seed and increasingly producing foundation seed

Private	P/P
Niche	Public

Variety Research & Development	Variety Selection & Breeding	Breeder Seed Production & Maintenance	Foundation Seed Production	Quality Seed Production	Marketing & Distribution

Current State

1. AfricaRice Center
- AfricaRice partners with other research centers around the world to develop improved varieties
- Location: Ibadan

2. National Agricultural Research System (NARS)
- Nationally funded research centers (some located within universities) that collaborate with other international research institutes (i.e. AfricaRice) on research and development of locally adapted varieties
- Locations: Six regional Agricultural Research Institutes (ARIs) in Nigeria

3. National Cereal Research Institute (NCRI),
- Nigeria-based research institution that collaborates with other international research institutes (i.e. AfricaRice) to develop improved varieties

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2. National Cereal Research Institute (NCRI)
- Nigeria-based research institution that collaborates with other international research institutes (i.e. AfricaRice) to develop improved varieties

1. National Agricultural Seed Council (NASC)
- Nationally funded government institution that produces foundation seed. Receive breeder seed from NCRI and NARS

2. Private Seed Companies
- Commercial seed companies often produce their own foundation seed

1. Private Seed Companies
- More than 80 private companies in Nigeria producing quality rice seed

2. Contract Growers
- Contracted by private seed companies or NGOs to multiply foundation seed into quality seed

1. National Agriculture Seed Council (NASC)
- Nationally funded government institution that supports marketing and distribution efforts

2. Private Seed Companies
- Fund their own marketing and distribution for quality seed in pre-identified and through agro-dealers

3. NGOs
- Support marketing and distribution efforts

Legend: Type of actor investing in each value chain stage

Private Sector ***Public Sector*** ***Public-Private*** ***IARCs w/ private sector & NARS***

Source: Expert Interviews

2a In the ideal state, the private sector would produce foundation and quality seed, with the public sector playing a strong role in marketing and distribution

Private	P/P
Niche	Public

Variety Research & Development	Variety Selection & Breeding	Breeder Seed Production & Maintenance	Foundation Seed Production	Quality Seed Production	Marketing & Distribution

Ideal State

1. AfricaRice Center
- AfricaRice partners with other research centers around the world to develop improved varieties
- Location: Ibadan

2. National Agricultural Research System (NARS)
- Nationally funded research centers (some located within universities) that collaborate with other international research institutes (i.e. AfricaRice) on research and development of locally adapted varieties
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1. National Agricultural Research System (NARS)
- Nationally funded research centers (some located within universities) that collaborate with other international research institutes (i.e. AfricaRice) on research and development of locally adapted varieties
- Receives private funding to for breeder seed of varieties of interest to private sector

2. National Cereal Research Institute (NCRI)
- Nigeria-based research institution that collaborates with other international research institutes (i.e. AfricaRice) to develop improved varieties
- Receives private funding to for breeder seed of varieties of interest to private sector

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- Nationally funded government institution that supports marketing and distribution efforts

2. Private Seed Companies
- Fund their own marketing and distribution for quality seed in pre-identified and through agro-dealers

3. NGOs
- Support marketing and distribution efforts

Ideal State: Private companies pay government institutions for breeder seed, offsetting public sector costs, and also produce quality and foundation seed, with government phasing out of rice foundation seed production and reallocating resources towards less commercially viable crops

Legend: Type of actor investing in each value chain stage

Private Sector ***Public Sector*** ***Public-Private*** ***IARCs w/ private sector & NARS***

Source: Expert Interviews, Monitor Deloitte Analysis

2a Given the high seeding and multiplication rates, rice production is sustainable if demand is stable and guaranteed

Private	P/P
Niche	Public

Breeder Seed – 0.2 MT		Key Observations and Insights *(see Appendix for detailed costs and assumptions)*
Variable Cost (1%)	$355 (1%)	Fixed labor is the largest cost driver for breeder seed
Fixed Cost (99%)	$62,040 (99%(	
Total Breeder Seed Cost	$62,395	
Total Profit	($54,190)	Breeder seed production is expensive because of the technical labor and training needed. Due to limited output of breeder seed, production needs to be publically supported
Profit Margin (%)	-661%	

Foundation Seed – 12.5 MT		
Variable Cost (30%)	$8,510 (30%)	Labor and planting equipment are the largest cost drivers for foundation seed production, but high seeding and multiplication rates keep this stage profitable
Fixed Cost (70%)	$19,735 (70%)	
Total Foundation Seed Cost	$28,245	
Total Profit	$505	While 2% profitability is not high enough to sustain a private business, a quality seed producer could vertically integrate profitably and manage this stage in the value chain. Public support for breeder seed inputs could also be used to make foundation seed production more profitable
Profit Margin (%)	2%	

Quality Seed – 1,000 MT		
Variable Cost (58%)	$457,800 (58%)	Consistent with the earlier pieces of the value chain, labor and planting / irrigation equipment are the largest cost drivers in production
Fixed Cost (42%)	$326,250 (42%)	
Total Quality Seed Cost	$784,050	
Total Profit	$435,950	High multiplication and seeding rates make rice production sustainably profitable if demand is high enough
Profit Margin (%)	36%	

Due to high multiplication and seeding rates, quality seed production is profitable if demand is guaranteed and stable, though low volume of breeder seed demanded necessitates public support for sustainability

Notes:
(1) Costs represent one variety since producing several varieties is only marginally more costly. Additional costs that may be incurred would come out in management, labor, and land costs.
(2) Costs represent a typical seed producer's cost to produce seed of market-standard quality at the time it is demanded, though this could pose a greater challenge for some producers versus others
(3) "Breeder Seed" includes both the production of breeder seed (technology commercialization) and the R&D, variety selection and breeding efforts required to develop new varieties

Private	P/P
Niche	Public

2a In an ideal state, several enabling factors can help ensure successful private investment in the rice seed value chain and ensure sustainable, consistent profitability

Policy / Regulatory	**Conducive Policy & Regulatory Framework**	• No EGS production restrictions • IP protections exist and are enforced • Regulation is stable and predictable	• No policies that discourage private entry into the sector (e.g. excessive tax) • Consistent trade policy
Value Chain Capacity	**Technical & Management Capabilities**	• Sufficiently educated workforce exists • Training programs are adequate for required technical proficiency	• Managers have foundational business skills and knowledge (i.e., book keeping, accounting)
	Market Linkages & Data Availability	• Sufficient linkages exist to understand upstream supply and downstream demand and evaluate risk and potential upside	• Market data allows actors to measure performance against competitors
Seed Market	**Sufficient Demand**	• Consumer willingness to pay is greater than production cost • Demand is stable and predictable	• Improved varieties offer desirable traits and command a price premium
Quality Assurance	**Reliable Quality Assurance Mechanism**	• Quality assurance processes exist and are consistently enforced • Mechanism is credible and trusted	• Costs should not be prohibitive for enforcement or compliance • Variety release process is expedient
Supporting Environment	**Access to Sufficient Land & Infrastructure**	• Land rights regime allows sufficient access to productive land	• Physical infrastructure supports production and distribution (roads, irrigation, storage)
	Access to Capital and Financing	• Access to financing and low interest loans to fund working capital and capital investments in facilities, equipment, etc.	• Farmer access to loans and financing to purchase planting material and inputs • Tools for risk mitigation (e.g., insurance)

Source: Expert Interviews, Monitor Deloitte Analysis

Private	P/P
Niche	Public

2a

Nevertheless barriers exist that need to be addressed

Policy / Regulatory	**Conducive Policy & Regulatory Framework**	• Inconsistent and changing policies create uncertainty in the market, and discourage private sector investment
Value Chain Capacity	**Technical & Management Capabilities**	• Lack of technical capacity and resources by producers (i.e., seed companies, NARS, universities) results in poor quality breeder, foundation and quality seed
	Market Linkages & Data Availability	• The distribution of breeder seed to foundation seed producers is poorly coordinated and monitored, resulting in an inadequate supply of quality breeder seed to producers • Lack of seed processing facilities limits the quality of seed that can be processed • Poor seed distribution and marketing efforts; agro-dealers often located in urban areas
Seed Market	**Sufficient Demand**	• Consumers in urban areas prefer imported rice over local varieties • Lack of awareness and low demand for improved varieties of seed since seed companies lack the resources to fund significant extension /promotional activities
Quality Assurance	**Reliable Quality Assurance Mechanism**	• Quality assurance for breeder seed in particular is weak due to inadequate funding for QA implementation • Weak QA mechanism by the NASC has led to counterfeit and adulterated quality seed
Supporting Environment	**Access to Sufficient Land & Infrastructure**	• Limited storage infrastructure, irrigation, and machinery for production
	Access to Capital and Financing	• High interest rates on financing prevent smaller private companies from entering the sector

Source: Expert Interviews, Monitor Deloitte Analysis

Private	P/P
Niche	Public

2a

Government and donors can play a role in addressing and overcoming these barriers

			Lead Actor and Role
Policy / Regulatory	**Conducive Policy & Regulatory Framework**	• Maintain policy commitments and strengthen enforcement mechanisms of existing policies (i.e., imports) • Incentives for private companies to produce foundation seed (e.g., tax exemptions, infrastructure)	• Gov. of Nigeria, policy
Value Chain Capacity	**Technical & Management Capabilities**	• International ag. education exchange programs and fellowships • Incentivize seed companies to train farmers in the proper use of their seed, associated agronomic practices, etc.	• BMGF; funding, liaison • Gov. of Nigeria, policy
	Market Linkages & Data Availability	• Develop a business case for private rural extension services for to encourage distribution of quality seed of improved varieties • Capacity building efforts to encourage better distribution record keeping	• Gov. of Nigeria, policy • BMGF, USAID
Seed Market	**Sufficient Demand**	• Incent private seed companies to produce foundation seed to ensure higher quality commercial seed • Ensure crops of improved varieties meet consumer quality standards by supporting infrastructure and production practices	• Gov. of Nigeria, policy • USAID
Quality Assurance	**Reliable Quality Assurance Mechanism**	• Build technical capacity of NASC through accreditation, authorization, or licensing of inspectors to improve QA • Stricter enforcement of anti-counterfeit policies	• USAID • Gov. of Nigeria
Supporting Environment	**Access to Sufficient Land & Infrastructure**	• Build irrigation infrastructure for off-season production so that overall production can be increased	• Gov. of Nigeria
	Access to Capital and Financing	• Ensure existing policies and efforts to increase financing in the agriculture sector (i.e., NIRSAL) support the seed sector (e.g., quotas on seed production loans)	• Nigeria Central Bank

Source: Expert Interviews, Monitor Deloitte Analysis

Private	P/P
Niche	Public

2a

Conclusion and Implications for Market Archetype 2a

Reflections on Sweet Potato in Tanzania:

- Sweet Potato is a popular food crop in Tanzania, and though public and donor breeding produce white and orange-fleshed varieties, much focus has lately been on Vitamin A-rich orange-flesh sweet potato (OFSP), which has seen very low adoption
- Farmers tend to replant their own vine cuttings from year to year or source planting materials from the informal market, which makes up 99% of the total market, though material from this channel is more susceptible to pests and disease
- Demand for processed sweet potato for higher-value commercial uses is not that high and is unstable, as these uses are not popular are dependent on the prices of substitute goods which vary based on weather, disease pressure, etc.
- Private tissue culture labs have potential as foundation seed producers in the future, but private sector activity in the market is still small and is unlikely to be profitable until demand for quality planting material increases enough to enable greater scale

Reflections on Rice in Nigeria:

- Nigeria has set ambitious goals for import substitution of rice in the next few years, and has undertaken aggressive policies of trade protections and public investment in land, inputs, and processing capacity to support the growing industry
- Consumers have historically preferred imported rice, to the point that it has been smuggled into the country extensively, creating uncertain demand for domestically produced rice seed as the government tries to stop smuggling and shift consumer preferences

Overall Implications for Market Archetype 2a Seed Sectors:

- Where demand is strong but unpredictable, government support for the supply-side (e.g., research) is often not sufficient and should be supplemented by demand-side support to mitigate the effect of demand uncertainty
- While the public sector should play a key role in the research and breeding of these crops, it must be responsive to market pulls and not only push varieties that advance a public policy goal, and this can be facilitated by collaborating with the private sector

Archetype 2a Key Takeaway: *In cases where private sector investment is limited by demand risk, government policy should focus on risk mitigation tools for private companies and donors can affect sustainable change by supporting the availability and quality of data for forecasting demand in a mature market*

Public-Private Archetype 2b Business Model Example: Cowpea in Ghana

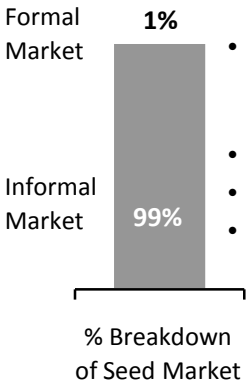
Content:

- Background
  - Overview of the sector
  - Existing goals and public / donor efforts to address gaps
  - Current and ideal state of the major actors and their role in the value chain
- Economics of seed production: An overview of the revenue, costs, and margins, as well as required support (if any) to sustain production of the following
  - Breeder Seed
  - Foundation seed
  - Quality seed
- Key enabling factors to support the ideal state
- Barriers and challenges to overcome
- Recommendations

2b Cowpea is a very important crop in Ghana; although domestic production has been increasing, production still does not meet demand

Private	P/P
Niche	Public

Industry Size and Overview



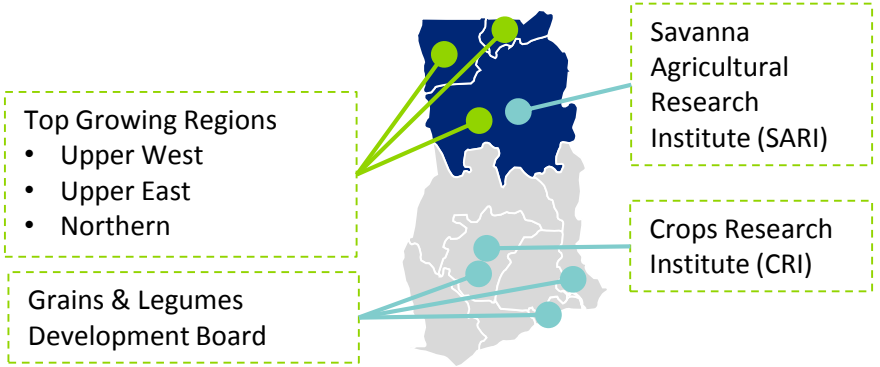
- **Production of cowpeas is 219,300 MT** per annum on **163,700 Ha of land;** seed production is an average of **30MT** annually over the past 5 years
- Additional **3,380 MT imported** to meet demand
- **16 Improved varieties**, but only **3 are produced**
- Quality seed of improved varieties is mainly produced by **private growers** registered with the Plant Protection & Regulatory Services Directorate (PPRSD) and members of **SEEDPAG** (310 registered members of the Association)
- Breeder Seed is produced mainly by the **Savanna Agricultural Research Institute** (SARI) and the **Crops Research Institute** (CRI)
- Foundation Seed is mainly produced by the **Ghana Grains and Legume Development Board**

Market

- **85% of cowpea is used for human consumption**, 15% used for livestock feed and seed
  - Preference for large cowpeas that taste good & are easy to cook
- Desirable variety characteristics include insect **pest resistance, drought tolerance, and high yield**
- **Crop risks include:**
  - Insect pests (during every stage of life cycle)
  - Parasitic weeds, *Striga and Alectra,* choke the plants' growth
  - Low adoption of quality seed
- New seed law allows companies to use their own branded packaging, and at least 5 companies do so

Growing Regions

- Cowpea is well adapted to tropical and sub-tropical areas and is tolerant to **high temperatures, drought**, and **poor soil conditions**
- **Current Yield:** 1.3 MT/Ha
- **Achievable Yield:** 2.6 MT/Ha



Programs of BMGF, USAID, and the World Bank

BMGF:

- Tropical Legumes II
- At least 2 AGRA-PASS-supported companies produce cowpea seed
- Investing in research, storage, and distribution of improved cowpea seeds through (Integrated *Striga* Management in Africa Project)
- Developing low cost cowpea storage bags
- Stanbic/AGRA Loan Guarantee Program under which AGRA guarantees Stanbic loans (20% in year 1, 15% yr. 2, 10% yr. 3-5)

USAID finances Ghanaian Agriculture Project, a FtF Innovation Lab w/ SARI and CRI, and has started cowpea seed scaling project w/IITA

World Bank's Ghana Commercial Agriculture Project seeks to facilitate access to land and private sector financing, while promoting PPPs and smallholder linkages, using $100M investment

Sources: "Farmer's key production constraints…" University of Ghana; "Saving Africa's maize and cowpea…" Modern Ghana 2012; "AATF plans commercialization of pod borer resistance cowpea," AATF 2013; MOFA Facts and Figures; Purdue Univ.; "Ghana Develops GM Cowpea," Modern Ghana; Carana Corporation; IFAD, World Bank, IITA, ICRISAT, IFPRI, CSIR-SARI, AGRA, USAID

2b Government and donors are seeking to introduce and disseminate quality cowpea seed of improved varieties to improve yields for farmers

Private	P/P
Niche	Public

Government / Donor Priorities	Current Challenges	Existing Investments and Interventions
Improve Smallholder Farmer Livelihoods	• Cowpea is widely grown by rural households and offers value from consumption, animal feed, and income, but lack of quality seed of improved varieties—i.e. higher yielding, pest or disease resistant—keeps yields below potential yields • Cowpea enriches the soil it grows in, thus it is beneficial for cereal growers to intercrop cowpea	• The government invests in the development and breeding of new varieties that have higher yields, drought-resistance, or resistance to pests, diseases, and parasitic weeds – New varieties are developed at research institutes CSIR-SARI and CSIR-CRI, under the Council for Scientific and Industrial Research – The public sector also invests in foundation seed through the Grain and Legume Development Board, though more private actors are becoming involved at this stage • Past and present government and donor programs support smallholder farmers' access to financing, for example: – Government of Ghana: Rural and Agricultural Finance Program, rural microfinance – USAID: Financing Ghanaian Agriculture Project, technical assistance and incentives – BMGF: STANBIC/AGRA Loan Guarantee Program
Nutrition and Food Security	• Cowpea is a cheap source of protein and an important food source in Ghana, so increasing yield is important for guaranteeing a stable and nutritious food supply	

Sources: Sub-Saharan Africa Financing Ghanaian Agriculture Project (USAID-FinGAP); Rural and Agricultural Finance Programme (RAFiP); AgriFin, Access to Agriculture Finance in Ghana; Expert Interviews

2b Currently, the public sector is involved in early generation seed production, with NGOs supporting marketing and distribution efforts

Private	P/P
Niche	Public

Variety Research & Development	Variety Selection & Breeding	Breeder Seed Production & Maintenance	Foundation Seed Production	Quality Seed Production	Marketing & Distribution

Current State

1. International Institute for Tropical Agriculture (IITA)

- IITA provides germplasm to CSIR for release within Ghana or breeding for local adaptation
- Location: Accra and Tamale

2. Savannah Agricultural Research Institute (CSIR-SARI)

- One of two national crop research institutions under CSIR, which primarily services the dryer northern regions of Ghana by breeding cowpea varieties for local adaptation, often in collaboration with IITA
- Location: Tamale

3. Crops Research Institute (CSIR-CRI)

- One of two national crop research institutions under CSIR, which primarily services the forest regions in the south of Ghana by breeding locally adapted varieties of cowpea, often in collaboration with IITA
- Location: Kumasi

1. Research Institutions (CSIR-SARI and CSIR-CRI)

- SARI selects varieties from among national and international germplasm and conducts breeding to develop locally adapted varieties for the dry, northern regions of Ghana, while CRI does the same for the forested, southern regions

1. Research Institutions (CSIR-SARI and CSIR-CRI)

- SARI maintains genetic material and produces breeder seed for varieties it has developed or adapted for local conditions, while CRI does the same for its varieties

1. Grain and Legume Development Board (GLDB)

- Public body historically responsible for foundation seed production, in addition to offering storage and seed processing services, though regulations have been relaxed due to low capacity and chronic undersupply

2. Research Institutions (CSIR-SARI and CSIR-CRI)

- SARI and CRI have recently begun producing foundation seed themselves due to low supply from GLDB

3. Small Seed Enterprises

- SME companies and farmer-based organizations have begun production of foundation seed in addition to quality seed, in light of the implementation of the new seed law in 2011 which opened foundation seed production to private sector

1. Seed Producers Association of Ghana (SEEDPAG)

- Association of scattered, small seed producers that evolved from past cluster of public outgrowers, produces and sells seed at the price set by the government

2. Private Seed Companies

- Growing class of SME seed companies and farmer-based organizations produce quality seed for commercial sale

1. Seed Producers Association of Ghana (SEEDPAG)

- Facilitate some direct marketing and distribution of seed to farmers, for seed not sold to agro-dealers

2. Private Seed Companies

- Conduct some direct marketing and distribution of seed to farmers, for seed not sold to agro-dealers

3. Private Agro-Dealers

- Purchase quality seed from seed companies on credit for sale to farmers

4. NGOs

- Purchase seed from private companies to give to farmers as part of interventions

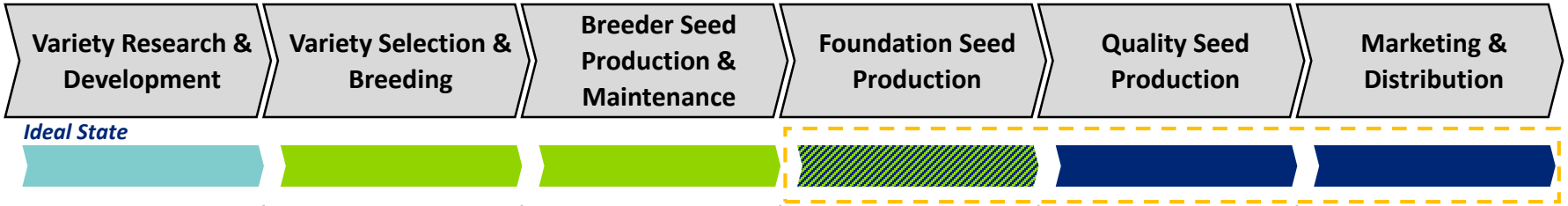
Legend: Type of actor investing in each value chain stage

Private Sector ***Public Sector*** ***Public-Private*** ***IARCs w/ private sector & NARS***

Source: Expert Interviews

2b In the ideal state, the private sector is responsible for foundation seed production, with the public sector providing support in early stages of the value chain

Private	P/P
Niche	Public



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1. Grain and Legume Development Board (GLDB)

- Historically responsible for foundation seed production, in addition to storage and seed processing services, ***2. Research Institutions (CSIR-SARI and CSIR-CRI)***
- SARI and CRI have begun producing foundation seed due to low GLDB supply

3. Small Seed Enterprises

- SME companies and farmer-based organizations produce all foundation seed, in addition to quality seed, in light of the implementation of the new seed law in 2011 which opened foundation seed production to private sector

Ideal State: GLDB and CSIR do not produce foundation seed, but offer support services and subsidized inputs to private producers

1. Seed Producers Association of Ghana (SEEDPAG)

- Association of scattered, small seed producers that evolved from past cluster of public outgrowers
- Informally set prices as a collective for quality seed

2. Private Seed Companies

- Growing class of SME seed companies and farmer-based organizations produce quality seed for commercial sale

1. Seed Producers Association of Ghana (SEEDPAG)

- Handle some direct marketing and distribution of seed to farmers

2. Private Seed Companies

- Handle some direct marketing and distribution of seed to farmers

3. Private Agro-Dealers

- Purchase quality seed from seed companies on credit for sale to farmers

4. NGOs

- Purchase seed from private companies give to farmers as part of interventions

Ideal State: NGOs exit seed distribution as the private sector develops capacity to meet farmer demand without public or donor support

Legend: Type of actor investing in each value chain stage

Private Sector ***Public Sector*** ***Public-Private*** ***IARCs w/ private sector & NARS***

Source: Expert Interviews, Monitor Deloitte Analysis

2b Given the demand for quality cowpea, quality seed production can be privately produced with public support for breeder and foundation seed production

Private	P/P
Niche	Public

Breeder Seed – 0.6MT

		Key Observations and Insights *(see Appendix for detailed costs and assumptions)*
Variable Cost (23%)	$63,325 (23%)	Breeding efficiency is very low, takes 5-7 years to release a new variety, delaying any potential revenue and introducing risk *(numbers reflect one year of breeder activity, with two full-time breeders)*
Fixed Cost (77%)	$211,425 (77%)	
Total Breeder Seed Cost	$274,750	Because breeder seed production requires highly-skilled labor and technology with relatively low revenue, and takes many years develop a new variety, the public sector needs to support this stage of the value chain
Total Profit	($272,878)	Breeder seed is high cost with very small returns due to low multiplications rates and low volume of breeder seed demanded. While this is an extremely important step in the value chain, it will need to be publically supported to be sustainable
Profit Margin (%)	-14,554%	

Foundation Seed – 25MT

Variable Cost (22%)	$16,450 (22%)	Salaries and land remain the highest fixed costs for foundation seed production, as high skill is required to oversee the process for quality purposes; breeder seed inputs and processing and storage of foundation seed are the highest variable costs
Fixed Cost (78%)	$60,000 (78%)	
Total Foundation Seed Cost	$76,450	Although the private sector can produce foundation seed most efficiently, the public sector needs to provide support to producers to ensure profitability potentially by providing subsidized breeder seed inputs
Total Profit	($1,450)	At this scale, foundation seed production is close to break-even (or slightly profitable with breeder seed inputs subsidized), however, at current Ghana production of 70MT, foundation seed production is extremely unprofitable, similar to breeder seed production. Until scale is reached, foundation seed production will need to be publically supported
Profit Margin (%)	-2%	

Quality Seed – 1,000 MT

Variable Cost (71%)	$800,000 (71%)	Fixed costs are limited to labor costs for quality seed production and variable costs increase with the additional need for land, distribution, and processing
Fixed Cost (29%)	$323,000 (29%)	
Total Quality Seed Cost	$1,123,000	Given the volume of demand and prices of quality cowpea, quality seed production is an economically viable model without public support
Total Quality Seed Revenue	$2,000,000	With quality seed selling at ~$2,000 per MT, quality seed production is a profitable enterprise
Total Profit	$877,125	Quality seed can be largely profitable once seed scale is achieved through breeder and foundation seed multiplication. At scale, there is an opportunity for quality seed producers to vertically integrate and support foundation seed production without significant damage to profitability
Profit Margin (%)	44%	

Given the complexity, cost, and time needed to produce cowpea breeder seed, the public sector should provide targeted support for breeder seed production. Foundation seed will also need public support until scale is reached and the private quality seed producers can vertically integrate.

Notes:
(1) Costs represent one variety since producing several varieties is only marginally more costly. Additional costs that may be incurred would come out in management, labor, and land costs.
(2) Costs represent a typical seed producer's cost to produce seed of market-standard quality at the time it is demanded, though this could pose a greater challenge for some producers versus others
(3) "Breeder Seed" includes both the production of breeder seed (technology commercialization) and the R&D, variety selection and breeding efforts required to develop new varieties

2b In an ideal state, several enabling factors can help increase efficiency in the cowpea seed value chain and ensure scale

Private	P/P
Niche	Public

Policy / Regulatory	**Conducive Policy & Regulatory Framework**	• No EGS production restrictions • IP protections exist and are enforced • Regulation is stable and predictable	• No policies that discourage private entry into the sector (e.g. excessive tax)
Value Chain Capacity	**Technical & Management Capabilities**	• Sufficiently educated workforce exists • Training programs are adequate for required technical proficiency	• Managers have foundational business skills and knowledge (i.e., book keeping, accounting)
	Market Linkages & Data Availability	• Sufficient linkages exist to understand upstream supply and downstream demand and evaluate risk and potential upside	• Market data allows actors to measure performance against competitors
Seed Market	**Sufficient Demand**	• Farmer willingness to pay is greater than production cost • Demand is stable and predictable	• Improved varieties offer desirable traits and command a price premium
Quality Assurance	**Reliable Quality Assurance Mechanism**	• Quality assurance processes exist and are consistently enforced • QA mechanism is credible and trusted	• Costs should not be prohibitive for enforcement or compliance • Variety release process is expedient
Supporting Environment	**Access to Sufficient Land & Infrastructure**	• Land rights regime allows sufficient access to productive land	• Physical infrastructure supports production and distribution (i.e., roads, irrigation, storage)
	Access to Capital and Financing	• Low interest access to financing and loans to fund working capital and capital investments in facilities, equipment, etc.	• Farmer access to loans and financing to purchase planting material and inputs • Tools for risk mitigation (e.g., insurance)

Source: Expert Interviews, Monitor Deloitte Analysis

Private	P/P
Niche	Public

2b

Nevertheless barriers exist that need to be addressed

Policy / Regulatory	**Conducive Policy & Regulatory Framework**	• Continued lack of IP protection, as plant breeders' rights bill has not yet passed • Foundation seed production has only been open to the private sector since 2011
Value Chain Capacity	**Technical & Management Capabilities**	• Seed companies lack access to technical training on efficient production practices • GLDB lacks human capital capacity to meet foundation seed demand • Breeders have to travel long distances to supervise multiplication sites for quality
	Market Linkages & Data Availability	• Public research agenda has historically been incoherent and based on donor projects • Weak extension service support limits linkages between public breeding and foundation seed programs and farmers and their demands
Seed Market	**Sufficient Demand**	• Input subsidies introduce uncertainty into the market and may distort demand • Varieties supplied are often mismatched with the locally adapted varieties preferred by farmers, potentially due to the long lag time to release a new variety (5-7 years)
Quality Assurance	**Reliable Quality Assurance Mechanism**	• Ghana Seed Inspection Directorate (GSID) is chronically under-resourced, and has not yet attempted a less resource-intensive system such as accreditation/authorization
Supporting Environment	**Access to Sufficient Land & Infrastructure**	• Access to irrigation is low, which delays planting in areas that are prone to drought • Access to storage is low, restricting producers' ability to maintain seed stocks • Transportation infrastructure is poor and hampers distribution
	Access to Capital and Financing	• Low availability of credit from commercial banking sector cannot meet financing needs of seed companies, though numerous public and donor programs seek to increase financing access for smallholder farmers, potentially supporting demand for seed

Source: Expert Interviews, Monitor Deloitte Analysis

Private	P/P
Niche	Public

2b

Government and donors can play a role in addressing and overcoming these barriers

			Lead Actor and Role
Policy / Regulatory	**Conducive Policy & Regulatory Framework**	• Engage legislators and stakeholders in passing IP protections • Develop business case studies for private seed companies and decrease public investment in foundation seed production	• BMGF, convening agent • USAID, funding source
Value Chain Capacity	**Technical & Management Capabilities**	• International ag. education exchange programs and fellowships • Shift GLDB from production to support for private sector, e.g. funding breeders to oversee private foundation seed production	• BMGF; funding, liaison • Gov. of Ghana, policy
	Market Linkages & Data Availability	• Deepen trend analysis for demand forecasting for breeding • Invest in extension service and link closely with breeding and seed production to better match supply and demand	• World Bank, funding • Gov. of Ghana, funding
Seed Market	**Sufficient Demand**	• Subsidize foundation seed inputs, e.g. subsidized breeder seed • Deepen trend analysis and invest in extension services to improve responsiveness of breeding and production	• Gov. of Ghana, funding • World Bank and Gov. of Ghana, funding
Quality Assurance	**Reliable Quality Assurance Mechanism**	• Implement sustainable quality assurance process, such as accreditation/authorization, licensing of field inspectors, truth-in-labeling	• BMGF, funding source
Supporting Environment	**Access to Sufficient Land & Infrastructure**	• Some form of subsidy (e.g. tax exemption) for private companies to develop infrastructure, e.g. irrigation, storage	• Gov. of Ghana, policy
	Access to Capital and Financing	• Channel existing government and donor programs for credit toward seed specifically, including loan guarantees, portfolio requirements, and microfinance	• World Bank and Gov. of Ghana, funding

Source: Expert Interviews, Monitor Deloitte Analysis

Private	P/P
Niche	Public

2b

Conclusion and Implications for Market Archetype 2b

Reflections on Cowpea in Ghana:

- The formal market for quality cowpea seed is very small, with ~70 MT covering ~1.7% of land cultivated with cowpea, well below the scale required to make production profitable due to the high costs of multiplying early generation seed for several seasons
- Early Generation Seed production was only opened to the private sector in 2011 after many years of state control by the under-resourced Grain and Legume Development Board, so private investment in this area is still small
- Ghana has a strong network of small seed growers (Seed Producers Association of Ghana) that produces most quality seed, as well as some larger local seed companies, but access to financing is weak so private companies often cannot afford the long time horizon required for breeding, particularly for cowpea which has relatively low multiplication rate and requires multiple seasons

Overall Implications for Market Archetype 2b Seed Sectors:

- For crops that require significant capital investments or have high fixed costs for breeding (e.g., cassava in Ghana, common bean in Zambia), the private sector is unlikely to invest in research and development and breeding; these highly capital-intensive operations can be conducted centrally and at the greatest scale by the government
- For crops that require a long time to market, for example, legumes with low multiplication rates, there is a risk that breeding will be unresponsive to market demands due to the delay, and there is a need for sophisticated trend analysis to overcome this
- Foundation seed production is also unlikely to be profitable on its own due to low volume and high fixed costs, but private actors may be able to do so more efficiently than the public sector if they receive financing and input support (e.g. breeder seed)
- With these supports in place, if scale can be achieved, fixed costs are low enough for quality seed that private companies can sustainably produce quality seed and handle marketing and distribution on a decentralized basis to reach rural smallholder farmers

Archetype 2b Key Takeaway: *Even if demand is reliable, research and breeding for certain crops has very high fixed costs that will need to be supported by the government until very large scale can be achieved; donors can play a key role in linking breeding to markets and helping to understand varieties that will be demanded in the future*

Private Archetype 3 Business Model Example: Sorghum in Ethiopia

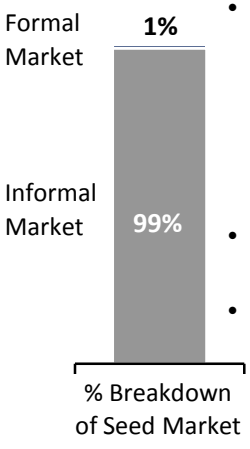
Content:

- Background
  - Overview of the sector
  - Existing goals and public / donor efforts to address gaps
  - Current and ideal state of the major actors and their role in the value chain
- Economics of seed production: An overview of the revenue, costs, and margins, as well as required support (if any) to sustain production of the following
  - Breeder Seed
  - Foundation seed
  - Quality seed
- Key enabling factors to support the ideal state
- Barriers and challenges to overcome
- Recommendations

3 Sorghum is largely a food security crop in Ethiopia; the early generation seed sector is entirely supported by the public sector

Private	P/P
Niche	**Public**

Industry Size and Overview



- Production of sorghum is estimated to be **3.8 million MT**, by **4.8M holders**, on **1.7M ha**
  - Limited imports and exports
  - Commercial market for grain is small, but demand is increasing as teff prices rise, even for open-pollinated varieties
- National average **yield is 2.3 tons/ha**, lower than the global average of 3.2 tons/ha
- **Private involvement in seed production is low**
  - Low seeding rate and small sizes of farms lead to low profitability for private sector
  - High price makes quality seed of improved varieties less affordable to smallholder farmers

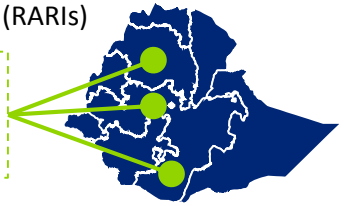
Market

- Sorghum is mainly a **food subsistence crop** with low commercialized end uses
- Farmers **dominantly use informally sourced local varieties**, but demand for quality seed of improved varieties is increasing
  - In the past four decades, **25+ OPV varieties were released**
- Desirable traits include early maturing, stay-green, high biomass, high yield, leaf and grain disease tolerant/resistant (i.e. striga)
- Crop risks include **common disease, avian, striga**

Growing Regions

- Sorghum typically grows in lowland areas, usually **400 to 2500m altitude**
- Drought resistance allows sorghum to grow in dry regions with moderate rainfall
- Main research, nucleus, and breeder seed facilities:
  - Ethiopian Institute of Agricultural Research (EIAR)
    - Biggest research center, located in Addis Ababa
  - Regional Agricultural Research Institutes (RARIs)

Sorghum is produced across Ethiopia with about **90% of the output from three regions:** Oromiya, Amhara and Tigray



Programs of BMGF, USAID, and the World Bank

BMGF:

- Gave $4M to University of Queensland (AU) for research on drought-tolerant sorghum varieties, which also engaged the Govt. of Ethiopia
- Harnessing Opportunities for Productivity Enhancement (HOPE) of Sorghum and Millets implemented by ICRISAT and ISSD Ethiopia

USAID:

- FtF in Ethiopia focuses on food security enabled by agricultural growth, by linking smallholders and vulnerable populations to markets, and fostering an enabling environment conducive to investment and growth

World Bank:

- Agricultural Growth Program (AGP) aims to increase productivity and commercialization through development of small-scale infrastructure and access to technology, marketing, processing, and mgmt practices

Sources: ICRISAT Report; "Agricultural Research and development in Ethiopia" by Efrem Bechere; ASTI Country Brief; "The Political Economy of Ethiopian Cereal Seed Systems;" "Getting Genes," by Shawn McGuire; Ethiopia Strategy for Sorghum 2014-2024, EIAR; USAID Feed the Future; World Bank Agricultural Growth Program; PhilanthropyNewsDigest.com

3 Most farmers use informal local varieties of sorghum that are prone to drought; efforts to introduce improved varieties have not been very successful

Private	P/P
Niche	**Public**

Government / Donor Priorities	Current Challenges	Existing Investments and Interventions
Food Security and Smallholder Farmer Livelihoods	• Farmers tend to prefer local landraces with high stover content for animal feed, housing materials, and fuel, but these may have lower yields than improved varieties or lack resistance to drought or parasitic weeds like *Striga*, resulting in deficit production	• Numerous international research institutes and US public universities conduct research and development on new sorghum varieties with public and donor funding, specifically to improve resistance to drought and Striga and other weeds, pests, and diseases • Breeder seed is produced by the Ethiopian Institute for Agriculture Research (EIAR) and regional institutes, while foundation and quality seed are produced by the Ethiopian Seed Enterprise (ESE), all with public funding
Utilization of Unproductive Land	• Adoption of improved varieties is low, including for those with improved drought tolerance, causing it to be less productive or less frequently planted than is optimal	• Currently sorghum is not a priority crop for the ATA, and the EIAR and RARIs do not dedicate many resources to sorghum, resulting in low-quality early generation seed and low adoption of improved varieties, which limits the success of any of these programs

Source: Getting Genes, Wageningen University; Ethiopian Strategy for Sorghum 2014-2024, EIAR; Expert Interviews

3 Because improved varieties of sorghum are developed to ensure food security, the public sector supports all parts of the value chain

Private	P/P
Niche	**Public**

Variety Research & Development	Variety Selection & Breeding	Breeder Seed Production & Maintenance	Foundation Seed Production	Quality Seed Production	Marketing & Distribution
Current State					
1. ICRISAT (CGIAR) • ICRISAT partners with NARS to develop new varieties of sorghum • Location: Nairobi ***2. Ethiopian Institute for Agricultural Research (EIAR)*** • Nationally funded research system that collaborates with ICRISAT on breeding programs that benefit multiple regions • Locations: Many locations, primarily Melkassa and Werer, Chiro established in 2014 as sorghum COE ***3. Regional Agricultural Research Institutes (RARIs) and Universities*** • Six regional research institutes plus several universities, though most sorghum research and breeding occurs at Oromiya and Amhara ARIs and Haramaya University • Locations: Many locations throughout Ethiopia	***1. Ethiopian Institute for Agricultural Research (EIAR)*** • EIAR selects and breeds varieties adapted for the country, using public and donor funding ***2. Regional Agricultural Research Institutes (RARIs)*** • RARIs select and breed varieties adapted to their regions—mainly Oromiya and Amhara—using public and donor funding	***1. Ethiopian Institute for Agricultural Research (EIAR)*** • NARS produces and maintain breeder seed of varieties bred by the federal system, using public and donor funding ***2. Regional Agricultural Research Institutes (RARIs)*** • RARIs produce and maintain breeder seed for their region, using public and donor funding	***1. Ethiopian Institute for Agricultural Research (EIAR)*** • NARS produces foundation seed from the breeder seed it produces, using public and donor funding ***2. Regional Agricultural Research Institutes (RARIs)*** • RARIs produce foundation seed from the breeder seed their produce, using their own budget, EIAR funding, and donor funding	***1. Ethiopian Seed Enterprise (ESE) and Regional Seed Enterprises (RSEs)*** • Parastatal seed enterprises receive foundation seed for free from NARS and RARIs and multiply into quality seed for certification using contracted farmers in their local region ***2. Cooperative Unions*** • Small regional farms work together to produce and distribute quality seed	***1. Ethiopian Seed Enterprise (ESE) and Regional Seed Enterprises (RSEs)*** • Parastatals aggregate seed from contracted farmers, market the seed allocated to their region by the Ministry of Agriculture, at the price set by regional Bureau of Agriculture ***2. Cooperative Unions*** • Almost all quality seed goes through regional unions of farmers for local marketing and distribution

Legend: Type of actor investing in each value chain stage

Private Sector | *Public Sector* | *Public-Private* | *IARC* | *Ethiopian terminology*

Source: Expert Interviews

3 In the ideal state, public resources are more responsive to farmers through a more decentralized model

Private	P/P
Niche	**Public**

Variety Research & Development	Variety Selection & Breeding	Breeder Seed Production & Maintenance	Foundation Seed Production	Quality Seed Production	Marketing & Distribution

Ideal State

1. ICRISAT (CGIAR)
- ICRISAT partners with NARS to develop new varieties of sorghum
- Location: Nairobi

2. Ethiopian Institute for Agricultural Research (EIAR)
- Nationally funded research system that collaborates with ICRISAT on breeding programs that benefit multiple regions
- Locations: Many locations, primarily Melkassa and Werer, Chiro established in 2014 as sorghum COE

3. Regional Agricultural Research Institutes (RARIs) and Universities
- Six regional research institutes plus several universities, though most sorghum research and breeding occurs at Oromiya and Amhara ARIs and Haramaya University
- Locations: Many locations throughout Ethiopia

1. Ethiopian Institute for Agricultural Research (EIAR)
- NARS select and breed for adapted varieties for the country, using public and donor funding

2. Regional Agricultural Research Institutes (RARIs)
- RARIs breed for adapted varieties to their regions—mainly Oromiya and Amhara, using public and donor funding

1. Ethiopian Institute for Agricultural Research (EIAR)
- NARS produces and maintain breeder seed of varieties bred by the federal system, using public and donor funding

2. Regional Agricultural Research Institutes (RARIs)
- RARIs produce and maintain breeder seed for their region, using public and donor funding

1. Ethiopian Institute for Agricultural Research (EIAR)
- NARS produces foundation seed from the breeder seed it produces, using public and donor funding
- Potentially could be contracted out to local seed businesses (LSBs) to improve efficiency

2. Regional Agricultural Research Institutes (RARIs)
- RARIs produce foundation seed from the breeder seed their produce, using their own budget, EIAR funding, and donor funding
- Potentially could be contracted out to local seed businesses (LSBs) to improve efficiency

1. Ethiopian Seed Enterprise (ESE) and Regional Seed Enterprises (RSEs)
- Parastatal seed enterprises receive foundation seed for free from NARS and RARIs and multiply into quality seed for certification using contracted farmers in their local region

2. Cooperative Unions
- Small regional farms work together to produce and distribute quality seed

1. Ethiopian Seed Enterprise (ESE) and Regional Seed Enterprises (RSEs)
- Parastatals aggregate seed from contracted farmers, market the seed allocated to their region by the Ministry of Agriculture, at the price set by regional Bureau of Agriculture

2. Cooperative Unions
- Almost all quality seed goes through regional unions of farmers for local marketing and distribution

Ideal State: Limited capacity of senior researchers means that researchers should be centralized at national research institutes, but these institutes must be better connected with more junior staff at RARIs so that the system as a whole can be responsive to farmer demands and breed varieties that will be widely adopted for a significant impact on smallholder farmer livelihood

Legend: Type of actor investing in each value chain stage

Private Sector ***Public Sector*** ***Public-Private*** ***IARC*** *Ethiopian terminology*

Source: Expert Interviews, Monitor Deloitte Analysis

Private	P/P
Niche	**Public**

3 Sorghum seed is generally given to farmers for free now, meaning the government supports the value chain fully at significant cost, mainly for personnel salaries

Breeder Seed – 25kg		**Key Observations and Insights** *(see Appendix for detailed costs and assumptions)*
VARIABLE COST	$4,462 (4%)	Variable costs are very small as the land area, land prep, and inputs required to produce this much breeder seed is small due to the high multiplication rate of sorghum, but fixed costs are very high for breeding staff, equipment, facilities, etc.
FIXED COST	$101,800 (96%)	
TOTAL BREEDER SEED COST	$106,262	Breeder seed is very expensive to produce on a per-unit basis, and is unlikely to be profitable at any scale as a standalone business; this is even more pronounced in a market where demand for sorghum seed is extremely low like Ethiopia
Foundation Seed – 3MT		
VARIABLE COST	$3,203 (3%)	Foundation seed also requires high fixed costs for breeders to allocate time to overseeing the process and for overhead for facilities, staff, etc., but variable costs are moderate due to skilled labor requirement being offset by low input requirement
FIXED COST	$51,800 (97%)	
TOTAL FOUNDATION SEED COST	$55,003	Foundation seed is relatively inexpensive to produce versus some other crops (e.g., hybrid maize) due to lower labor requirement, but would require significant scale to approach commercial viability
Quality Seed – 1,000 MT		
VARIABLE COST	$172,667 (77%)	Fixed costs are low for quality seed as it can be grown by contract growers with little overhead; variable costs are high due to high volume despite low per-unit costs, due to sorghum's high multiplication rate, low bulk, and low input requirements, as well as required bagging to avoid losses from bird damage
FIXED COST	$51,800 (23%)	
TOTAL QUALITY SEED COST	$224,467	Quality seed production makes up the bulk of the cost of seed production for the government, due to the higher land requirement and attendant costs such as planting, harvesting, field preparation, and some inputs

TOTAL QUALITY SEED REVENUE	$220,000	Sorghum is fully publicly supported, with farmers receiving a discount off of the already-subsidized prices of $0.45-$0.65/kg, and this results in significant cost to the government to safeguard food security; this will be have a significant effect on public funds as Ethiopia tries to scale up to ~12,000 MT by 2020
TOTAL COST OF PRODUCTION	$385,732	
TOTAL PROFIT	-$165,732	
PROFIT MARGIN (%)	-75%	

Quality sorghum seed is not profitable as a standalone enterprise without substantial subsidy, regardless of the price of foundation seed, due to the very low prices it can command from farmers; we estimate prices are currently discounted ~60% from the break-even price

Notes:
(1) Costs represent one variety since producing several varieties is only marginally more costly. Additional costs that may be incurred would come out in management, labor, and land costs.
(2) Costs represent a typical seed producer's cost to produce seed of market-standard quality at the time it is demanded, though this could pose a greater challenge for some producers versus others
(3) "Breeder Seed" includes both the production of breeder seed (technology commercialization) and the R&D, variety selection and breeding efforts required to develop new varieties

3 In an ideal state, several enabling factors can help increase efficiency in the sorghum seed value chain and ensure uptake by farmers

Private	P/P
Niche	**Public**

Policy / Regulatory	**Conducive Policy & Regulatory Framework**	• Crop is a strategic priority for the government and receives adequate attention and resources	• Demand forecasting and planning is done at the local / regional level to be responsive to local conditions
Value Chain Capacity	**Technical & Management Capabilities**	• Sufficiently educated workforce is present • Training programs are adequate for required technical proficiency	• Institutional leaders have foundational skills and knowledge to efficiently manage resources
	Market Linkages & Data Availability	• Sufficient linkages exist to understand upstream supply and downstream demand and farmer preferences for varieties	• Public investments are based on analysis of risk to crops from drought, disease, pests, etc. and likely uptake of varieties
Seed Market	**Sufficient Demand**	• Improved varieties offer desirable traits that farmers are willing to adopt	
Quality Assurance	**Reliable Quality Assurance Mechanism**	• Quality assurance processes exist and are consistently enforced • Mechanism is credible and trusted	• Certification and variety release should not be more stringent or costly than required by farmers and government stakeholders
Supporting Environment	**Access to Sufficient Land & Infrastructure**	• Adequate productive land is allocated for production to meet demand	• Physical infrastructure supports production and distribution (roads, irrigation, storage)
	Access to Capital and Financing	• Public funding is adequate for research and production, and allocation is transparent and stable	• Funding is contingent on outcome targets and agencies are accountable for managing resources and production efficiently

Source: Expert Interviews, Monitor Deloitte Analysis

Private	P/P
Niche	**Public**

3 Nevertheless barriers exist that need to be addressed

Policy / Regulatory	**Conducive Policy & Regulatory Framework**	• Sorghum is not currently a priority for the Agricultural Transformation Agency (ATA) • Production is not responsive to local farmer needs, since demand planning and decision rights are highly centralized in the Ministry of Agriculture (MOA)
Value Chain Capacity	**Technical & Management Capabilities**	• Limited interest in research and agriculture as a career path limits human capital capacity • Limited resources for training of researchers, breeders, and growers limits human capital • Limited breeder capacity is currently spread thinly across EIAR and RARIs
	Market Linkages & Data Availability	• Centralized breeding efforts are not well-connected to farmers and are not responsive to local demand and variety preferences
Seed Market	**Sufficient Demand**	• Farmers prefer traits of local landraces—e.g., stover content and biomass for fuel, animal feed, and building materials—and do not demand quality seed of improved varieties • Farmers prefer teff and wheat over sorghum
Quality Assurance	**Reliable Quality Assurance Mechanism**	• Seed Inspection Labs have low capacity and cannot meet national needs, allowing contaminated seed to be released as certified • Variety release policies are uniform across both commercial and subsistence crops, which may impose unnecessary costs on sorghum breeders and seed producers
Supporting Environment	**Access to Sufficient Land & Infrastructure**	• Limited infrastructure makes it difficult to distribute seed to remote locations and for farmers to learn about new varieties • Limited fertilizer inputs decrease quality seed adoption
	Access to Capital and Financing	• Government funding for sorghum is limited, and it is unclear whether it is tied to any sort of incentives or outcome targets • Micro-financing lending timelines are not aligned to planting seasons

Source: Expert Interviews, Monitor Deloitte Analysis

Private	P/P
Niche	**Public**

3 Government and donors can play a role in addressing and overcoming these barriers

			Lead Actor and Role
Policy / Regulatory	**Conducive Policy & Regulatory Framework**	• Develop a business case for making sorghum an ATA priority • Evaluate and design institutional framework for devolving some centralized planning functions to regional or local level	• World Bank; funding • USAID; diagnostic and Gov. of Ethiopia, policy
Value Chain Capacity	**Technical & Management Capabilities**	• International ag. education exchange programs and fellowships • Mentorship program between senior and junior researchers to build technical capacity and empower junior practitioners	• BMGF; funding, liaison • BMGF, Gov. of Ethiopia; funding, program dev.
	Market Linkages & Data Availability	• Tie breeder incentives (e.g. promotion) to adoption of varieties and quality of seed produced, not simply to publications	• Gov. of Ethiopia; policy
Seed Market	**Sufficient Demand**	• Implement participatory breeding programs at RARIs and formalize feedback mechanism to EIAR • Promote commercial end uses for sorghum to improve demand	• Gov. of Ethiopia; policy, funding
Quality Assurance	**Reliable Quality Assurance Mechanism**	• Implement sustainable QA process, e.g. licensed inspectors • Explore intermediate policies for variety release and certification, such as “locally certified seed”	• BMGF, funding source • Gov. of Ethiopia; policy
Supporting Environment	**Access to Sufficient Land & Infrastructure**	• Continue national investment in improving infrastructure • Consider subsidizing fertilizer and equipment with quality seed that responds to inputs, to promote adoption and success	• Gov. of Ethiopia; policy, funding
	Access to Capital and Financing	• Develop methodology for evaluating outcomes based on returns and design incentives to efficiently and timely allocate public funds	• World Bank, funding

Source: Expert Interviews, Monitor Deloitte Analysis

Private	P/P
Niche	**Public**

3

Conclusion and Implications for Market Archetype 3

Reflections on Sorghum in Ethiopia:

- Sorghum is one of the most important cereals in Ethiopia, though it functions mainly as an alternative to maize or teff that offers food security due to its ability to grow under abiotic stress
- Farmers have overwhelmingly used local varieties procured from the informal sector, though demand for quality seed of improved varieties has increased, and the government's goal is for 50% of seed to come from the formal market by 2020 (~12,000 MT)
- Breeding efforts have focused on tolerance to abiotic (drought) and biotic stress (parasitic weeds such as *Striga*) but sacrificed biomass, so farmers did not demand these varieties which had less household utility as animal feed, fuel, building material, etc.
- Sorghum is often grown in marginal economic areas by less affluent farmers, so willingness to pay for quality seed of improved varieties has been low, though commercial demand for sorghum is increasing and may shift this trend in the near future

Overall Implications for Market Archetype 3 Seed Sectors:

- Some crops with little or no commercial market are nonetheless critical to smallholder farmer livelihoods and food security, and thus should be supported by the public sector in order to advance both of these goals
- Despite the dominance of the public sector, breeding and production should be market-oriented to the extent possible, including being responsive to market demand in developing new varieties and implementing incentives for efficiency
- In cases where a crop offers little profit potential, the public sector can promote commercial crop markets to advance smallholder farmer livelihoods while increasing their willingness to pay for seed, which allows for recovery of some costs
- Weak quality assurance processes can damage farmers' trust and discourage them from purchasing quality seed of improved varieties, so a sustainable QA process is critical even in cases where commercial markets are small or nonexistent; new seed law codified the system of Quality Declared Seed (QDS), and the ATA and Ministry are currently preparing standards

Archetype 3 Key Takeaway: *Certain food security crops will require public support in order to safeguard against the possibility of a catastrophe, but these operations should still be managed efficiently to maximize returns on public investments and maximize the positive impact to smallholder farmers*

EGS Sector Archetype Content

- Market Archetype Overview and Approach
- Market Archetype Descriptions
  - Private Sector Dominant
  - Public-Private Collaboration Archetypes
    - Public Sector Mitigates Demand Risk
    - Public Sector Supports Breeder and Foundation Seed Production
  - Public Sector Dominant
  - Niche Private Sector
- Market Archetype Business Model Detail
  - Private Sector Dominant: *Maize in Zambia*
  - Public-Private Collaboration Archetypes
    - Public Sector Mitigates Demand Risk: *Sweet Potato in Tanzania, Rice in Nigeria*
    - Public Sector Supports Breeder and Foundation Seed Production: *Cowpea in Ghana*
  - Public Sector Dominant: *Sorghum in Ethiopia*
- **Government and Donor Recommendations**
- Background Research: Country and crop profiles

Summary of Recommendations to Donors and Governments

Based on the examples described in the previous section of this report, we identified the challenges to public and private actors in the seed sector that constrain scale. We also provided recommendations for potential interventions that could overcome these bottlenecks for the specific country crop examples. These challenges and associated solutions generally fall into two categories:

- **Inherent Economic Constraints of a Market Archetype:** The first type of constraint is unique to a market archetype and arises from the characteristics of seed and the demand for crops the seed produces. For example, the uncertainty around demand in Market Archetype 2a necessitates support for the demand-side of production. In contrast, the high fixed costs of producing breeder and foundation seed for crops in Market Archetype 2b require government or donor support for the supply-side of production in order for the value chain to be sustainable.

- **Constraints Imposed by the Enabling Environment:** The second type of constraint may cut across several market archetypes and arises from the enabling environment in a specific country context. For example, an inefficient regulatory regime or restrictive policy that limits pluralism in the market. Until these structural barriers are overcome, it will be difficult for any seed sector to scale in that country, regardless of the market archetype.

- The dividing line between these categories is not always perfectly clean, and certain enabling factors are more important for certain archetypes than others. For example, access to financing may be more important in a market with a stronger private sector, while adjusting public research incentive structures is more important when the public sector takes a larger role in breeding.

The following recommendations illustrate options available to governments, donors, and other stakeholders for addressing specific market barriers. These recommendations assume that under the specified conditions, the entities producing the seed could meet market requirements for quality and timing, though we recognize this is a significant challenge that may present a greater obstacle for some seed producers or in some geographies than in others.

Specific recommendations based on the economic constraints of Market Archetypes are laid out on slide 77. Recommendations for different areas of the enabling environment are laid out on slides 78 and 79.

Recommendations to overcome specific Market Archetype economic constraints to scale

1

Remove Market Distortions and Decrease Public Role

Support and advocate for policies that enable the private sector to grow sustainably

Potential Role of Government:
- Transition out of playing a direct role supporting the value chain (e.g., stop producing foundation seed)
- Remove distortionary subsidies and restrictions where possible

Potential Role of Donors:
- Demonstrate profit potential of the market through business cases
- Alleviate high fixed cost of breeders through capacity building
- Build capacity in banking sector to increase financing availability

Private Sector Dominant	**Public-Private Collaboration**
Niche Private Sector	**Public Sector Dominant**

3

Drive Public Sector Efficiency

Support efficiency of public entities through capacity building and organizational linkages

Potential Role of Government:
- Increase responsiveness of public breeding and production efforts by increasing farmer participation
- Implement more efficient QA processes to ensure more effective resource use, including through building private sector capacity

Potential Role of Donors:
- Build decentralized capacity throughout a country to better leverage public resources and reduce dependence on
- Implement monitoring and evaluation for public programs to understand impact and effectiveness of public investments

2a

Mitigate Demand Risk

Support stable and predictable demand and linkages between producers and markets

Potential Role of Government:
- Share demand risk with the private sector by backing financing and entering into surplus purchase arrangements
- Invest in extension services to increase demand in rural markets

Potential Role of Donors:
- Improve availability and accessibility of data to enable more accurate demand forecasting and planning of production
- Demonstrate private sector potential with business cases

2b

Subsidize Production Costs

Support breeder and foundation seed production by mitigating high fixed costs

Potential Role of Government:
- Directly subsidize fixed costs (e.g. breeders, certification) or back financing for capital investments, e.g. in technology
- Partly or fully fund production of breeder and foundation seed on an ongoing and stable basis (e.g., CGIAR, NARS)

Potential Role of Donors:
- Alleviate fixed costs by funding R&D and breeder training
- Ensure ROI on research by advocating for IP protections and linking breeding more closely to farmers' and market demand

Recommendations to overcome specific Market Archetype economic constraints to scale

1

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Potential Role of Donor

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- Alleviate fixed costs by funding R&D and breeder training
- Ensure ROI on research by advocating for IP protections and linking breeding more closely to farmers' and market demand

*Across all archetypes, the recommendations require actors to make **strategic trade-offs** in a way that results in a more efficient allocation of resources for all stakeholders.*

Governments and other regulatory / policy organizations can play a role in improving the enabling environment and building institutional capacity

Funding and Incentives

Policy & Regulatory Framework

Role: Enact and implement policies that allow for pluralistic approaches to seed production, whether fully private, public-private partnership, or public investment
Applicable Market Archetype: All
Rationale: Restrictions on actors involved in production limits potential investment and may cause inefficiency

Role: Remove trade restrictions, work toward quality standards harmonization, and limit distortionary demand subsidies
Applicable Market Archetype: Archetype 1, 2a, 2b
Rationale: Removing limitations on exports and minimizing government purchase of grain and seed minimizes price distortions in the market, which may negatively impact private seed companies

Market Linkages & Data Availability

Role: Tie breeder incentives (e.g. promotion) to adoption of varieties, not simply to publications
Applicable Market Archetype: Archetypes 2a, 2b, 3
Rationale: Provides incentive for breeders to take end-user preferences into account when producing new varieties, improving the changes of higher adoption

Sufficient Demand

Role: Fully support breeder seed production and subsidize foundation seed inputs, link subsidy eligibility to productivity gains
Applicable Market Archetype: Archetypes 2b, 3
Rationale: Ensures foundation seed production is financial viable, while also holding beneficiaries of the subsidy accountable for productivity gains

Role: Guarantee consistent demand through purchase of surplus or voucher provision
Applicable Market Archetype: Archetype 2a
Rationale: Lower the risk of production by guaranteeing a minimum demand be met for key food security crops

Strengthening Capabilities

Technical & Management Capabilities

Role: Require mentorship program between senior and junior researchers to build technical capacity, empower junior practitioners, and ensure continuity
Applicable Market Archetype: Archetypes 2a, 2b, 3
Rationale: Given high cost of training and aging workforce, efforts are needed to ensure new talent is prepared to meet production demand

Role: Incentivize seed companies to train farmers in the proper use of their seed, associated agronomic practices, etc.
Applicable Market Archetype: Archetype 1, 2b
Rationale: Increase proper use of quality seed of improved varieties by smallholder farmers to ensure long-term adoption of improved varieties and increased productivity

Reliable Quality Assurance Mechanism

Role: Implement sustainable QA process, e.g. licensed inspectors with annual technical refreshers, and explore intermediate policies for variety release and certification, such as quality declared seed (QDS)
Applicable Market Archetype: All
Rationale: Quality assurance is needed to establish trust in the formal seed market to encourage adoption of improved varieties

Access to Capital and Financing

Role: Channel existing government and donor financing programs to create sustainable mechanisms for financing of seed, including public loan guarantees and portfolio requirements, microfinance support, and a legal framework for public-private partnerships
Example Business Model Market: 1, 2a, 2b
Rationale: Affordable and stable financing is essential to private investment in seed production

Improving Value Chain Linkages

Sufficient Land & Infrastructure

Role: Continue national investment in improving infrastructure with potential subsidies (e.g. tax exemption) for private companies to develop infrastructure, e.g. irrigation, storage, isolation
Applicable Market Archetype: All
Rationale: Proper infrastructure and breeding/growing facilities and isolation are needed for quality varieties to be produced and multiplied

Role: Incent research institutes or companies to move processing functions to geographic locations that are underserved, potentially in a public-private partnership
Applicable Market Archetype: Archetype 3
Rationale: A more dispersed processing infrastructure will lower transportation costs to a centralized location and encourage distribution to more rural regional smallholder farmers for great adoption of improved varieties and increased productivity

Sufficient Demand

Role: Implement participatory breeding programs at regional research institutions and formalize feedback mechanism to national breeder institutions
Applicable Market Archetype: Archetypes 2a, 2b, 3
Rationale: Increase adoption of improved varieties by better matching supply with demand to ensure that varieties being produced meet unique regional needs

Donors and NGOs can play a variety of important roles in seed sectors, but should take care not to distort markets or crowd out the private sector

Facilitating Stakeholder Engagement

Policy & Regulatory Framework

Role: Fund and facilitate convenings to engage legislators and stakeholders in passing IP protections
Applicable Market Archetype: Archetype 1, 2a, 2b,
Rationale: IP rights are critical for private company investment in EGS production; facilitating the legislative discussion among policy makers will help expedite the enactment of this legislation

Role: Develop business case studies as proof-of-concept for private seed companies investment in foundation and quality seed production, or govt. prioritization of a crop
Applicable Market Archetype: All
Rationale: Demonstrate profitability and feasibility to encourage private investment

Sufficient Land & Infrastructure

Role: Analysis of optimal structure for private processing facilities to help governments create incentive structures that encourage more rural distribution
Applicable Market Archetype: All
Rationale: Transportation of EGS seed to centralized processing facilities is costly due to dispersed growing plots; decentralized processing facilities would decrease initial transport costs and allow quality seed to be transported to more rural areas throughout regions

Sufficient Demand

Role: Help the government demonstrate to farmers the benefits of higher-value commercial uses of the end crop to increase price premium and margins (e.g., demonstration plots, field days, etc.)
Applicable Market Archetype: All
Rationale: Educating the market on commercial uses for crops can increase demand and profitability of seed production, especially in cases where companies are reluctant to invest in the sector due to demand risk

Strengthening Capabilities

Technical & Management Capabilities

Role: Fund start-up costs and program development for operational data collection and bookkeeping training
Applicable Market Archetype: All
Rationale: Limited knowledge in booking and data collection make efficiency and profitability at each stage of the value chain difficult to analyze and limits the ability for private and public actors to make informed investment decisions

Role: International ag. education exchange programs, fellowships, and mentorship between researchers
Applicable Market Archetype: All
Rationale: The cost of breeders and lack of capacity is prohibitive to breeder seed development and accounts for nearly all of the fixed costs at this stage of the value chain; increased access and affordability of technical knowledge will help alleviate this barrier

Reliable Quality Assurance Mechanism

Role: Help build sustainable quality assurance process by providing training for the development of a certification,, accreditation/authorization licensing of field inspectors, or truth-in-labeling program
Applicable Market Archetype: All
Rationale: Quality assurance is needed to establish trust in the formal seed market to encourage adoption of improved varieties

Sufficient Demand

Role: Deepen trend analysis capabilities for demand forecasting for breeding through training programs and analytics education
Applicable Market Archetype: 2a, 2b, 3
Rationale: Allow private market players to better understand and predict demand for more stable market investment

Improving Value Chain Linkages

Market Linkages & Data Availability

Role: Develop business case to demonstrate and evaluate profit potential of widening distribution network(i.e., agents and agro-dealers)
Applicable Market Archetype: Archetype 1, 2a, 2b
Rationale: Building a business case for increased distribution of quality seed will encourage private companies to sell to rural smallholder farmers, increasing the adoption of quality seed and the growth of private companies

Role: Test innovative solution prototypes for increasing profitability of dispersed distribution, e.g. mobile-based seed ordering to aid in distribution planning
Applicable Market Archetype: All
Rationale: Proving the effectiveness of innovative programs to reach small scale farmers and providing a business case for reaching these consumers could encourage private companies to sell to rural smallholder farmers, increasing the adoption of quality seed and the growth of private companies

Role: Aggregation service for market data on demand, prices, etc.
Applicable Market Archetype: All
Rationale: Limited data quality and availability limits the ability for private and public actors to make informed investment decisions

Access to Capital and Financing

Role: Explore options for banks or govt. to gain experience in the ag. sector and offer sustainable lending to companies and smallholder farmers, e.g. loan guarantees, portfolio requirements, microfinancing
Applicable Market Archetype: All
Rationale: Affordable and stable financing is essential to private investment in seed production

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- Government and Donor Recommendations
- **Background Research: Country and crop profiles**

Background Research: Country and Crop Profiles

The following slides provide a brief snapshot of the country and crops being covered in this study.

Tanzania: The public sector in Tanzania is heavily involved in EGS production, while the private sector is relatively weak and fragmented

Tanzania Seed Industry Overview

Policy / Regulatory Environment

Overview: *The seed sector, historically government run, was privatized with the introduction of the Seed Act of 2003, however the private sector has been slow to get involved with early-generation seed production*

Seed Act of 2003 and seed Regulation of 2007: Key legislation that laid out procedures and regulations on importation, exportation, production, processing, distribution and sale of seed, and established TOSCI (Tanzania Official Seed Certification Institute), the sole seed certification agency

Protection of New Plant Varieties (Plant Breeders Rights) Act, 2002: IP rights legislations that introduced new and independent protection system for new plant varieties to promote plant breeding activities, stimulating, facilitating, and improving agricultural research in the country

National seed Committee: An advisory body to the Ministry of Agriculture responsible for variety release

Tanzania Seed Certification Institute (TOSCI): The sole agency mandated to manage seed production quality and regulation (new varieties, foundation seed, and certified seed); all foundation seed was produced by the public Agricultural Seed Agency, though recent regulatory changes allow private companies to contract with ASA to produce it, or license breeding material from the Ministry of Agriculture from the ARIs

Donor Investment: Donor supported programs began with World Bank and USAID support in the 1970s, and have more recently included investments from BMGF and AGRA, and others has supported the progress in productivity and usage of quality seed of improved varieties (i.e. National Agricultural Input Voucher Scheme) and seed certification processes

Value Chain Capacity and Resources

Overview: *Research centers are localized with the goal to ensure that local needs and agricultural conditions are incorporated into innovation approaches*

Division of Research and Development (DRD): The National Agricultural Research System (NARS) has the mandate to oversee all matters related to agricultural research; consisting of:

- **Agricultural Research Institutions (ARIs):** Zonal research centers focus on crops and issues relevant to their agro-ecologies to breed new varieties; new varieties are submitted to TOSCI and must undergo three years of testing before being approved for production (imported varieties from other Eastern African countries need only one season of verification before being registered)
- 393 scientists (48 PhDs, 165 MSc degree holders, 180 BSc degree holders) supported by 225 technicians

Source: AGRA-PASS MTR, 2010; Aline East African Synthesis Report, 2011; Tanzania Country Report, 2009; (5) BMGF Tanzania Seed Sector Assessment; The World Bank Agribusiness Indicators: Tanzania; Interviews with crop and country experts

Tanzania: While the private sector is growing, there are substantial infrastructure and quality assurance constraints

Tanzania Seed Industry Overview

Seed Market

Overview: *While the private seed sector is growing, it is very fragmented, with a large portion of formal seed being imported; in the formal market, ~80% of quality seed of improved varieties comes from the private sector*

54 private seed companies have been registered in Tanzania

- Total Seed Demand: ~212,000 MT per year, which may underestimate the rate of farmer-saved seed
- Total Sales from Formal Seed Market: 10 – 15,000 MT, only about 4 - 6,000 MT are produced locally
  - Some experts place current local production capacity closer to 25-30 MT annually, as most of the 54 private companies produce locally
  - Most imported seed are from multinational corporations, primarily from Zimbabwe and Kenya
  - In the formal market, 79% of quality seed of improved varieties is private sector; 21% from the government
- Private companies use contract farmers to produce local hybrid and OPV varieties of maize; oil crops (sunflower and sesame), sorghum and legumes (including mainly beans and vegetables)
- Government Seed Farms produce quality seed for other crops (e.g. millet, rice, cow peas)

Quality Assurance Mechanisms

Overview: *Quality Assurance is required through government regulations, though the regulating body (TOSCI) has extreme capacity constraints; private accreditation/authorization is not yet established in Tanzania*

Tanzania Seed Certification Institute (TOSCI): Must register all new varieties (conduct Distinctness, Uniformity and Stability (DUS) tests and the National Performance Trials (NPT)); random inspections occur throughout the year to ensure that the seed in the marketplace is true to type (quality assurance) and properly labeled

Agricultural Seed Agency (ASA): Mandated to produce, process, and market foundation seed for varieties bred from ARIs; ASA currently operates five government seed farms and seed processing facilities, though other actors are increasingly beginning to produce their own foundation seed, either under contract with ASA or by licensing directly from the MOA and ARIs

Supporting Environment

Overview: *There are key infrastructure shortages for seed processing and packaging; subsidy funding programs over the years have not had demonstrable impact, and the sector has remained relatively stagnant*

Infrastructure Development: Key challenges for the industry include insufficient numbers of contract growers, low quality seed, lack of storage facilities, shortages of trained staff, and infrastructure challenges; only ~5 of the seed companies have their own processing facilities, and ~5 more use ASA's facilities

Financing Availability: Funding for breeding and producing foundation seed comes from the Ministry of Agriculture and donors, though it is limited; the National Agricultural Input Voucher Scheme (NAIVS) was in place to subsidize the rice and hybrid maize seed, but the World Bank recently cut funding

Source: AGRA-PASS MTR, 2010; Aline East African Synthesis Report, 2011; Tanzania Country Report, 2009; (5) BMGF Tanzania Seed Sector Assessment; The World Bank Agribusiness Indicators: Tanzania; Interviews with crop and country experts

Zambia: Government intervention in maize markets creates demand uncertainty that discourages private investment in seed production, though other seed sectors generally function fairly well

Zambia Seed Industry Overview

Policy / Regulatory Environment

Overview: *Inconsistent unpredictable government policies and trade restrictions cause market distrust*

GOVERNMENT INVOLVEMENT: The government supported private sector involvement in the agriculture sector following the seed crisis in the 80s and 90s, but has shifted toward increased intervention in the sector recently

- While demand-side policies such as seed and fertilizer subsidies (FISP), maize buying programs (FRA), and import/export bans affect seed producers, the government generally doesn't intervene in the seed sector

REGIONAL HARMONIZATION: Zambia has taken a lead role in harmonization efforts by COMESA and SADC, the latter of which was released recently and has located its Seed Centre in Lusaka

PLANT VARIETIES AND SEEDS ACT (1964): Regulation and control of seed production; sale, import, and export of seed for sowing; and testing for germination and purity and seed certification; offers a high degree of market freedom

PLANT BREEDERS RIGHTS ACT (2007): Protects plant breeders' rights, including both ownership and use, and provides for registration of plant varieties, which encourages seed market development by protecting intellectual property

SEED CERTIFICATION AND CONTROL INSTITUTE (SCCI): The primary institution for variety selection, testing, and registration, and seed certification, accredited by the International Seed Testing Association

ZAMBIA NATIONAL FARMERS UNION (ZNFU): Advocacy group that allows farmers to shape important agricultural policy decisions to fit their interests and needs, which ultimately impact the demand for seed

- Ad hoc bans of exports or imports of maize frequently occur in years of production surplus or production deficit as a way of dealing with price fluctuation, resulting in uncertainty in the market
  - Stakeholders perceive agricultural policy as being politically driven, rather than by their needs and priorities
  - 83% of tariff lines are unbound and can be changed without discussion with trade partners

Value Chain Capacity and Resources

Overview: *Zambia's research labs are generally not well equipped, have limited capacity, and move slowly*

ZARI: State agricultural research body, headquartered at Mount Makulu with an adequate laboratory, and the soil lab is not yet internationally accredited

UNIVERSITY OF ZAMBIA'S AGRICULTURAL DEPARTMENT: The only other lab capable of agricultural testing

- SCCI has a laboratory, but it is specialized for seed testing
- The lack of high-quality laboratories outside ZARI and UNZA is a significant constraint on agricultural research
  - Another laboratory elsewhere in the country could dramatically shorten the time for examination and analysis of everything from soil samples to pesticides
- Technical training is needed, especially for variety testing, to improve the technical assistance for community seed enhancement and local inspection programs

Source: "Breeding an "Amaizing" Crop," CIMMYT 2011; "The Changing Structure of the Maize Seed Industry in Zambia: Prospects for Orange Maize," AAAE 2012; "AgCLIR: Zambia," USAID 2011; "Sorghum and Pearl Millet Improved Seed Value Chains in Zambia: Challenges and Opportunities for Smallholder Farmers," University of Nebraska 2010; Interviews with crop and country experts

Zambia: Smallholder farmers are constrained in their use of quality seed of improved varieties by poor infrastructure, poor access to financing, and limited seed diversification outside of maize

Zambia Seed Industry Overview

Seed Market

Overview: *Formal markets are more developed than other countries in SSA with a heavy focus on maize*

- Strong public sector with 11 seed companies playing largely regional roles; these are largely responsible for variety development and seed production due to low public investment
- More than most of its regional neighbors, Zambia has a large and well-developed formal seed sector meeting domestic and regional demand, especially for maize seed, and has led regional harmonization efforts
- Smallholder farmers overwhelmingly focus on maize, and lack of seed diversification is a key sector constraint
  - To a lesser extent, smallholders also produce cassava, sorghum, rice, groundnuts, and sunflower seeds
- 20 to 30 new varieties are released annually: about half are maize, followed by tobacco, cotton, and beans
- Private sector does not perceive the public sector as a reliable partner in agricultural development due to unpredictable policy changes (import/export bans), though its seed policy tends to be stable

Quality Assurance Mechanisms

Overview: *The human and technological resources of the Seed Certification and Control Institute do not meet the variety selection and seed certification needs of the sector, though it does generate an independent revenue*

Seed Certification and Control Institute (SCCI): The primary institution for variety selection, testing, and registration, and seed certification, accredited by the International Seed Testing Association

- Charges for services and keeps fees as a revenue stream, minimizing its funding requests to the Ministry of Ag.
  - By self-funding, the institute has more freedom to invest in needed staff, improvements for the laboratory (where the largest building was condemned), and modern equipment
- Licenses, registers, and inspects all seed multipliers using accredited private, local quality assurance providers
  - Alert SCCI to local outbreak of disease or appearance of fake seed
- SCCI has a generally positive reputation and is considered honest and competent by many stakeholders

Supporting Environment

Overview: *Commercial farms generally have access to adequate infrastructure and financing, though these resources generally do not reach smallholder farmers*

Infrastructure Development: Feeder roads, locations of post-harvest storage facilities, and widely publicized price information are lacking in Zambia markets, limiting the participation opportunities for smallholders

Financing Availability: Commercial farmers generally have access to financing, but tools for smallholder farmers are lacking, including crop insurance, microfinance, secured lending on storage facilities and movable property

- Smallholder farmers have no contact with banks or microfinance institutions, as borrowers or depositors
- Unpredictable regulations and poor loan enforcement contribute to the high interest rates (median of 20%)

Source: "Breeding an "Amaizing" Crop," CIMMYT 2011; "The Changing Structure of the Maize Seed Industry in Zambia: Prospects for Orange Maize," AAAE 2012; "AgCLIR: Zambia," USAID 2011; "Sorghum and Pearl Millet Improved Seed Value Chains in Zambia: Challenges and Opportunities for Smallholder Farmers," University of Nebraska 2010; Interviews with crop and country experts

Ghana: The EGS sector is in the nascent stages of liberalization after decades of state control, and will need strong implementation and institutional capability-building to continue momentum

Ghana Seed Industry Overview

Policy / Regulatory Environment

Overview: *A new seed law passed in 2010 is ambitious in its scope and intent, but implementation is thus far incomplete and this ongoing process will ultimately determine the impact of the law*

PLANT AND FERTILIZER ACT OF 2010: The new seed law that was recently enacted, the most significant provision of which is to liberalize production of all classes of seed, including by domestic private sector and foreign (public and private actors); beyond that provision, most specifics are left up to regulations yet to be finalized

PLANT BREEDER'S RIGHTS BILL: An as yet unpassed piece of legislation that will codify Ghana's first IP regime for new varieties and incentivize domestic private sector activity, which faces fears over MNC appropriation of local genetic material and infringement on farmers' rights to traditional, local varieties

NATIONAL SEED COUNCIL: New governing body for the seed industry established by the Plant and Fertilizer Act, responsible for setting seed policy, developing registration procedures for the new national variety registry, and setting up the authority for seed certification; composed of the Dir.-General of CSIR, two directors from MOFA, one representative each from SEEDPAG, the farmer's association (GNAF), the biotechnology research institute, and the University, along with a farmer representative and two presidential appointees

SUBSIDY PROGRAM: Despite low seed prices, MOFA maintains subsidies that keep seed prices at an average of 37%, the timing, variability, and amount of which all factor into farmer management decisions

Value Chain Capacity and Resources

Overview: *Research centers are localized to with the goal to ensure that local needs and agricultural conditions are incorporated into innovation approaches*

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH (CSIR): Crops Research Institute (CRI) and Savannah Agricultural Research Institute (SARI) have developed most improved varieties in the market along with universities, using germplasm from international centers

- Capacity has historically has been limited due to ongoing fiscal constraints for the central government
- Research agenda has historically been incoherent due to the heavy influence of donor funding and priorities
- Dissemination of new varieties to farmers is weak as the institutes focus on commercial crops

GRAIN AND LEGUME DEVELOPMENT BOARD (GLDB): Historically solely responsible for producing foundation seed from breeder seed from NARIs, but had chronically low capacity and was undersupplied. The new seed policy liberalized this arrangement, which could lead to private sector entry and/or an improved GLDB-esque intermediary

- Crops excluded from this system include rice and RTB crops, e.g. cassava and sweet potato

SEED PRODUCER ASSOCIATION OF GHANA (SEEDPAG): Association of small, scattered registered seed producers that informally sets seed prices each season as a collective; evolved from the past cluster of public outgrowers

Source: "Ghana's Commercial Seed Sector: New Incentives or Continued Complacency," IFPRI, 2013; Ghana Seed Sector Assessment, ISSD, 2012; Ghana Seed Entrepreneurship Assessment, ISSD 2013; MOFA.gov.gh; Interviews with crop and country experts

Ghana: The private sector is nascent but vibrant as newly passed and implemented policies increasingly encourage private sector investment in seed

Ghana Seed Industry Overview

Seed Market

Overview: *While the private seed sector is growing, it is very fragmented, with a large portion of formal seed being imported; the government produces all breeder and foundation seed*

~10 private seed companies operate in Ghana, all of which have emerged in the past few years and are gradually gaining share in a market previously dominated by the very small-scale producers of SEEDPAG

- Lack of variety exclusivity (IP rights) or differentiation makes it difficult to build brand loyalty or market share
- Small scale producers grow on their own small plots (a few Ha) and sell to input dealers, sometimes in pre-financed arrangements, producing OPV maize, rice, cowpea, and sorghum depending on demand
- Commercial contract grower schemes have arisen, managed by the larger private companies
- Even the larger private companies are still constrained by very old seed processing equipment
- Total Certified Seed Production: 5 - 6,000 MT annually, mostly a single variety of OPV maize, Obatanpa

Nascent MNC involvement in the sector, as Ghanaian firms Wienco and Agriserv have been importing foreign maize varieties from Pannar and Pioneer respectively, and DuPont Pioneer has recently embarked on a public-private partnership in the country, with all of this seed currently produced in South Africa

Quality Assurance Mechanisms

Overview: *Procedures for variety release have not been transparent and seed inspection and certification have not been adequately funded, but the new seed regulations will likely aim to facilitate both processes*

National Variety Registration and Release Committee (NVRRC): Intakes breeder seed and provides it to an independent body for two years each of two simultaneous trials, multi-location and on-farm, the standards for which are somewhat opaquely set by the Technical Variety Release Committee (TVRC)

Ghana Seed Inspection Directorate: Division of Plant Protection and Regulatory Services Directorate (PPRSD) of MOFA responsible for mandatory certification of all seed under the new seed law; though it is chronically under resourced, the new seed law and ECOWAS policies have opened the door to likely accreditation/authorization

Supporting Environment

Overview: *Infrastructure is strong with robust distribution networks developed by past donor projects and finance available to small seed producers, though the banking sector does not meet the financing needs of the sector*

Physical Infrastructure: Distribution enabled by the Ghana Agro-Dealer Development (GADD) project which digitized the distribution of over 4000 local agro-dealers through a text-message system

Financing Availability: Credit appears to be available mainly through larger companies as part of contract grower schemes or from input dealers; a small commercial banking sector exists, but need to investigate its efficacy

Source: "Ghana's Commercial Seed Sector: New Incentives or Continued Complacency," IFPRI, 2013; Ghana Seed Sector Assessment, ISSD, 2012; Ghana Seed Entrepreneurship Assessment, ISSD 2013; MOFA.gov.gh; Interviews with crop and country experts

Ethiopia: The government is highly involved in seed production and has restricted private sector involvement in the sector

Ethiopia Seed Industry Overview

Policy / Regulatory Environment

Overview: *Complex, multilayer bureaucracy characterizes all stages of the seed value chain, giving rise to onerous and inconsistently applied policies and increasing costs and uncertainty for public and private seed producers*

Ministry of Agriculture (MOA): Governing body responsible for formulating seed policy, variety registration and release, seed import/export and certification thereof, demand projection and regional allocation, etc.

Bureau of Agriculture (BOA): Regional body responsible for certification of privately produced seed—through the chronically underresourced and underperforming Seed Quality Inspection Labs—as well as extension services, and demand projections to drive public seed production; aggregate of publicly and privately produced seed of some crops for pricing and sale, though this role is diminishing as more companies are able to sell directly

- Centralization of functions results in conflicts of interest, so some states have separated responsibility certification and production among different agencies
- Central planning versus marketing leads to mismatched supply and demand, both in terms of quantity and variety, and keeps prices artificially low despite the lack of any formal subsidy or credit system

Agricultural Transformation Agency: Think-tank and facilitator for promoting transformation of the seed sector

Value Chain Capacity and Resources

Overview: *The Ethiopian government has traditionally taken a central and active role in the seed sector, and will likely continue to control all breeder and foundation seed production through the NARS in the near future*

National Agricultural Research System (NARS): Public research institution system composed of the federal Ethiopian Institute of Agricultural Research (EIAR) and six Regional Agricultural Research Institutes (RARIs) that conduct all R&D and breeding for varieties in Ethiopia, excluding MNCs (e.g., Pioneer)

- Breeder seed is produced by the breeder, which is exclusively limited to the public sector by law in Ethiopia
- Foundation seed is typically produced by the breeder, but may be produced by another designated body
- Research agenda mostly set by RARIs for their region, but set by EIAR for programs that benefit multiple regions

Ethiopian Seed Enterprise (ESE) and Regional Seed Enterprises: Public entities responsible for production, processing, distribution, and marketing of quality seed of improved varieties for all crops; the enterprises receive certification from the regional BoA in the region they are producing in; produces based on official BOA demand projections, which are then allocated by the MoA, though demand is often undersupplied due to lack of capacity

- Regional Seed Enterprises (RSEs) have similar responsibilities to ESE on a regional basis
- Primary crops are maize and wheat, together comprising 85% of total output

Farmers' Cooperative Unions: Semi-informal bodies that play a role in seed multiplication, distribution, and facilitate farmers' access to credit through interfaces with other institutions

Private Companies: Have a limited but slowly expanding role in seed production, mostly in hybrid maize

Source: Atilaw, Abebe, "A Baseline Survey on the Ethiopian Seed Sector," African Seed Trade Association, 2010; Ghana Seed Sector Assessment, ISSD, 2012; Ghana Seed Entrepreneurship Assessment, ISSD 2013; MOFA.gov.gh; Interviews with crop and country experts

Ethiopia: There are early signs of MNC interest and a stated desire on the part of the government to loosen policy restrictions, which may signal future growth of the nascent private sector

Ethiopia Seed Industry Overview

Seed Market

Overview: *Private sector is restricted to the most profitable crops and most productive geographies due to a weak enabling environment and a lack of seed marketing*

30 private seed companies primarily focus on hybrid maize, as well as potatoes and vegetables

- Many begin in contractual arrangements with public seed enterprises or regional BOA
- Seeds are purchased by regional BOA who aggregate public and private seeds, set prices, and disseminate through local farmers' groups, undermining private marketing efforts, depressing prices, and generally reduce incentives for private sector investment
- Difficult to do business, due to lack of access to foreign exchange to purchase equipment, lack of access to capital, and difficulty in accessing breeder or foundation seed and/or new and improved varieties
- The informal seed system (self-saved seed or farmer-to-farmer seed exchange) accounts for ~90% of seed used by smallholder farmers, leaving the formal market of quality seed of improved varieties with less than 10%

Country's agricultural research system has developed and released more than 664 varieties of 50 different crops

- ~71.3% of the total cultivated area is covered by major cereals, followed by legumes (11.5%), and oil seeds (6%)

Quality Assurance Mechanisms

Overview: *Publicly run certification labs do not have the capacity to meet the legal requirement that all seed be certified, which directly affects private seed companies that are not accredited to self-certify their own seed*

Public companies have internal quality assurance processes, but still have to be certified along with private companies by Seed Quality Inspection Labs, under the regional BOA, which are under-resourced and struggle to perform in a timely manner, affecting the viability of both public and private seed producers

Quality and Standards Authority of Ethiopia: Developed the national seed standards for testing and certification

Bureaus of Agriculture and Rural Development (BOA) in regional states (decentralized) implement seed inspection and certification; also manage 10 seed testing laboratories

- These labs have the capacity to conduct only 30,000 sample tests per year, much less than required for the public and private certified seed market

Supporting Environment

Overview: *Extension services do not support increased uptake of quality seed of improved varieties, despite the large public sector investment in extension*

Extension Services: Relatively strong network for dissemination from public entities through farmers' groups to farmers, but lack of capacity to increase farmers' knowledge of improved varieties or the value of quality seed

Local Seed Businesses (LSBs): Publicly-supported seed producer cooperatives holds promise for increasing supply

Source: Atilaw, Abebe, "A Baseline Survey on the Ethiopian Seed Sector," African Seed Trade Association, 2010; Ghana Seed Sector Assessment, ISSD, 2012; Ghana Seed Entrepreneurship Assessment, ISSD 2013; MOFA.gov.gh; Interviews with crop and country experts

Nigeria: Public sector agencies responsible for different parts of the seed sector value chain are often underfunded and inadequate for the country's early generation seed production needs

Nigeria Seed Industry Overview

Policy / Regulatory Environment

Overview: *With a highly federal system, Nigeria has many institutions involved in agriculture development, which are often uncoordinated at the state and national levels.*

HISTORY: Seed policy in Nigeria was given a legal framework by the Agricultural Seed Decree of 1992, which established the National Agricultural Seed Council (NASC) as the main policy body for the seed system and, beneath that body, the National Seed Service (NSS) in the Federal Department of Agriculture, which acts as the primary regulator of the seed industry.

POLICY ON FOUNDATION SEED PRODUCTION: The private sector is now permitted to produce its own foundation seed; it is also produced by the National Agricultural Seed Council (NASC), Agricultural Development Projects (ADPs), and Agricultural Research institutes

AGRICULTURAL TRANSFORMATION AGENDA: Launched in 2011, the ATA established a mechanism to de-risk lending in the sector (Nigeria Incentive-Based Risk-Sharing System for Agricultural Lending, NIRSAL), provides subsidies for fertilizers and inputs (Growth Enhancement Support Scheme, GESS), and establishes special zones to attract private sector processing plants (Staple Crop Processing Zones)

Value Chain Capacity and Resources

Overview: *Both public and private sector entities are significant in the formal sector value chain, with the public sector playing a leading role in breeding and foundation seed production, and the private sector playing the lead role in multiplying, marketing and distributing seed.*

VARIETY BREEDING: Local variety breeding is done by 10 National Agricultural Research Institutes (NARIs), two of which are embedded into Universities. The NARIs are mandated to conduct breeding for specific crops. Due to underfunding, however, the output of the research institutes is far below what is required. International Agricultural Institutes do most of the breeding to fill the gaps

FOUNDATION SEED: The NASC coordinates the production of foundation seed, through its own infrastructure and by contracting with the state level parastatal ADPs. Private companies are also involved with foundation seed production.

QUALITY SEED: Quality seed production is now mostly done by private seed companies.

DISTRIBUTION: Quality seed of improved varieties produced by the public sector are sold to the farmers through farmers' supply companies, agro service centers, ADPs, cooperative societies, etc. Many seed companies also produce and distribute seeds. Maize is the major crop of interest although some smaller companies sell cowpea, millet, sorghum, groundnut and soybeans

MARKETING: Information about the seed industry, especially about the availability of quality seed of improved varieties, is not readily disseminated to the farmers due to inadequate extension agents

Source: Nigeria AGRA-PASS MTR – September 2010; OyeKale, K.O., "Growing an Effective Seed Management System: A Case Study of Nigeria," *Journal of Agricultural and Environmental Sciences,* June 2014; Interviews with crop and country experts

Nigeria: Nigeria's seed sector has not developed to the level need to meet the needs of a large and growing population

Nigeria Seed Industry Overview

Seed Market

Overview: *Nigeria's seed system is relatively well developed, however, there is still a sizable need in the system given the large population and number of priority food security crops*

FORMAL VS. INFORMAL SECTOR: The formal sector accounts for less than 10% of seed supply, with the exception of cassava where it is estimated that 20% of planting material is supplied through formal channels

EXISTING PRIVATE SECTOR PARTICIPANTS: There are about 89 seed companies. These include:

- Premier Seed: Dominant seed company with the majority of the market share primarily selling hybrid maize and very active in northern Nigeria. The company also produces and distributes OPV of cereals, legumes, oil seed, and vegetables, however, is faces capacity challenges
- UT-Seedis: Maize varieties for the plateau (midaltitude) areas
- Alheri Seed: Hybrid maize seed and OPVs of cereals, legumes, and vegetables
- Savannah Seeds: Hybrid and open-pollinated maize

Quality Assurance Mechanisms

Overview: *Laboratories required for seed testing, seed certification, and quality assurance are not adequate, and those that are available are poorly equipped*

SEED CERTIFICATION AND QUALITY ASSURANCE: The laboratories required for seed testing, seed certification, and quality assurance are not adequate, and those available are poorly equipped. As a result there have been cases of unlabeled seeds being sold in markets and stores, with no sanctions or penalties

NATIONAL AGRICULTURAL SEED COUNCIL: The NASC has been more active in enforcing quality standards as a result of the support of the current Minister of Agriculture. Nevertheless, seed testing and field inspection are inadequate potentially due to poor funding and lack of oversight of the process

Supporting Environment

Overview: *Nigeria's agriculture sector faces many challenges, including poor roads and infrastructure, security issues, lack of financing, and corruption, among others*

HUMAN CAPITAL: There is generally a dearth of human capital in the key areas of seed science and technology. Most of the seed technologists available in the country were trained abroad. As a result, the federal government has developed a seed technology training center. The National Seed Service also offers vocational courses for people in the field. There is a need for a continuous training program for staff in seed development programs

INFRASTRUCTURE: Most rural areas are inaccessible due largely to the poor nature of the roads. The NSS has put in place the Community Seed Development Program with aim to diffuse the quality seed of improved varieties into rural communities. This scheme is not yet available nation-wide.

Source: Nigeria AGRA-PASS MTR – September 2010; OyeKale, K.O., "Growing an Effective Seed Management System: A Case Study of Nigeria," *Journal of Agricultural and Environmental Sciences,* June 2014; Interviews with crop and country experts

Common Bean and Cowpea: With low multiplication rates and high transport costs, cowpea and common bean rely on public support for research and market incentives

Common Bean & Cowpea

Common Bean and Cowpea Overview

Seed Attributes

Overview: *Beans have a low multiplication rate and high transportation costs, pushing margins down and making them historically unattractive to private companies*

- ~15% of the market purchases new seed year over year, the rest of the market uses recycled seed
- **Desirable Characteristics:** taste, drought resistance, disease resistance
- **End Uses:** consumption
- Beans have a low margins demanding public support to incentivize the production market
- A new variety takes 5-7 years to develop
  - Localization of the breed is important as consumer demands are localized
- Multiplication rates are low, one cowpea generates ~30-40 seeds – this is the a key constraint to rapid dissemination of varieties; low to moderate seed perishability
  - Demand exceeds supply for at least 5 years (in the US) after a new variety is released due to low multiplication rates, and penetration may take longer in Sub-Saharan Africa
- Seed volume and weight are large relative to other crops, making it difficult to transport seed

Research Capacity

Overview: *Several research institutes exist in Ghana, Tanzania, and Zambia, but are inconveniently located far from production plots; CIAT is a leading research organization for common bean globally (supported by donors), with a strong presence in Tanzania*

- **Research Institutes:** Among our target countries, leaders are SARI and CRI in Ghana; IITA and IAR in Nigeria; ZARI University of Zambia; ARIs in Tanzania (with CIAT support); many other African countries have strong or improving bean breeding programs as well (e.g., Burkina Faso, Senegal, Rwanda, Uganda, Kenya, and South Africa)
- US and Australia are the most advanced markets, and even there, bean breeding is still mainly in the public sector

Value Chain Challenges

Overview: *Lacking infrastructure capacity and restrictive international regulation disincentive the private sector from producing cowpea and common beans*

- Currently little to no private sector actors involved in research, only public-to-public research collaboration
- International barriers to exchange of germplasm across borders, hindering research and variety development
- Low capacity for bridging breeding with delivery systems: weight and volume of seed makes transport difficult
  - Transportation of breeder and foundation seed will need to be addressed any time multiplication sites are far from breeding sites, and breeders must travel to multiplication sites to ensure seed quality, identify off-types, etc.; the burden of these requirements will vary by country depending on size and infrastructure

Source: Boettiger, Sara et al. "Planning for Scale Brief #1: Tools for Scaling," Ag Partner Exchange, 2013, Figure 2, page 18; Interviews with crop and country experts

Sorghum: As a dry land cereal best suited to poorer, less productive regions with seed that is not usually renewed every year, sorghum is commercially unattractive and often publicly supported

Sorghum

Sorghum Overview

Seed Attributes

Overview: *Sorghum seed is inexpensive to produce (OPV), but the demand is depressed by farmers' saved seed and the price is kept low by low adoption of improved varieties and low ability of farmers to pay premium prices*

- **Desirable Characteristics:** grain yield, biomass, striga tolerance, early maturity, drought resistance, disease resistance, insect/pest resistance, starch and sugar content, stalk size, grain size/color, taste
- **End Uses:** food, malting/brewing, animal feed, fuel, building material
- Seed is often saved and replanted year over year, which keeps the demand for commercial seed very low, and what hybrid sorghum exists has not been widely adopted in Africa yet due to specific farmer demands
- Sorghum can be grown in dry areas where few other crops grow productively, meaning it is often relegated to marginal agricultural zones where farmers are generally poorer and strongly attached to traditional landraces
- Many uses exist, from traditional uses in subsistence, animal feed, and housing materials, to evolving industrial applications in food production, and fuel, which require higher-quality sweet sorghum seed, and malting/brewing
- Multiplication rate is high at ~1plant to 200 seeds, moderate bulk density (721 kg/m3) and seed perishability so costs of production and transportation are relatively low

Research Capacity

Overview: *National research institutes in each target country have mandates to breed new varieties of sorghum, but they are often under resourced and require significant donor support and international germplasm*

- **Research Institutes:** Two NARIs in Ghana; ICRISAT supports EIAR in Ethiopia, DRD in Tanzania, and IAR in Nigeria
- These struggle with human capital, facilities, and funding without donor support, and are largely understaffed in breeders; staff needs training in modern breeding tools and technology, data collection, management, and analysis

Value Chain Challenges

Overview: *Shortage of qualified domestic breeders hamstrings R&D, low commercial interest in traditional varieties hinders commercial production, and low farmer awareness impedes adoption of improved varieties*

- Currently little to no private sector actors involved in research, only public-to-public research collaboration, and partnerships are weak across the value chain, which result in a lack of good market information
- Lack of farmer demand for sorghum hybrids and lack of awareness of improved varieties and their value are barriers to adoption and thus private sector involvement in the sector
- Low market pull for grain hurts adoption of improved varieties, and increased market pull, including from new sorghum value chains, will increase demand and will be critical to seed system sustainability, especially for hybrids
- NARIs struggle to find adequate breeders and are largely understaffed
- National institutes focus on improving existing landraces for farmers, which have low commercial interest, because developing hybrid varieties is often too costly

Source: Boettiger, Sara et al. "Planning for Scale Brief #1: Tools for Scaling," Ag Partner Exchange, 2013, Figure 2, page 18; Interviews with crop and country experts

Cassava: Traditionally publicly supported due to its difficult EGS production processes and being a food security crop, new industrial markets have recently developed for high-starch cassava

Cassava

Cassava Overview

Seed Attributes

Overview: *Cassava seed is relatively expensive to produce and distribute, with long lead-times required for research and breeding due to low multiplication rates, making it unattractive to the private sector*

- **Desirable Characteristics:** disease/drought resistance, high starch content/quality, high dry matter, cooking quality
- **End Uses:** consumption (fresh, fried, processed as fufu, akpu, gari) brewing, starch for industrial processing, flour
- Cassava is highly susceptible to diseases—including catastrophic ones like brown streak (mostly East Africa) and less damaging diseases that simply hurt yield, such as mosaic--which determines demand for clean planting material and improved varieties with disease resistance
- Low multiplication rates (3-10 seeds per plant) and high transportation costs due to bulky seed and high seed perishability make it expensive to produce at scale, especially in a centralized system
- No opportunity cost associated with saving seed, since planting materials is stems, not the starchy root
- 8-10 years to bring a new variety from research to release, which makes it difficult to predict demand on such a long time horizon, including a best-case scenario of 3-4 years of multiplication from breeder seed to commercial
- Most R&D and breeding done by tissue culture, though this system is not yet perfected for cassava

Research Capacity

Overview: *Many NARS have a mandate to focus on bringing quality planting material of improved varieties of cassava to farmers, with support from IITA, though private interest in this research has been very limited*

- **Research Institutes:** No private sector research, all conducted by NARS, which may be specialized for RTB crops, such as the NRCRI in Nigeria, or simply have cassava as a mandated focus crop, such as the DRD in Tanzania
- **IITA:** Working on improved varieties with NARS; may not be adequately connected to diverse end-market demands such as for processed starch products, which may have higher market pull from the private sector

Value Chain Challenges

Overview: *Demand for quality seed and improved varieties varies greatly by country and region depending on disease pressure and very diverse array of end-markets, including processing for food and industry*

- Currently little to no private sector actors involved in research, only public-to-public research collaboration, due to long, laborious process of research, development, and breeding and technical difficulty of tissue culture
- Private processors favor high-starch varieties, which do not always align with those demanded for consumption
- Disease pressure is a double-edged sword that creates risk to investment in seed in areas of high disease pressure, but demand for quality planting material is lower in areas of low disease pressure
- National institutes tend to operate under poor conditions with low human and technological resources
- Certification is an ongoing challenge, as vegetative planting material is more technically difficult to certify and the inspection systems have received little investment due to low commercial interest – often sold on trust

Source: Boettiger, Sara et al. "Planning for Scale Brief #1: Tools for Scaling," Ag Partner Exchange, 2013, Figure 2, page 18; Interviews with crop and country experts

Rice: Traditionally produced by the public sector due to low demand for quality seed, increasing demand for high quality rice in end markets may provide an opportunity for more private actors

Rice

Rice Overview

Seed Attributes

Overview: *Rice seed is moderately inexpensive to produce and transport, but farmers save seed for many years and rely primarily on local varieties d suited to their local agro-ecological context*

- **Desirable Characteristics:** disease resistance, grain size/color, aroma, amylose content, tolerance to abiotic stresses
- **End Uses:** consumption
- Local varieties are specific to an agro-ecology, e.g. upland, lowland, irrigated, etc. and most breeding focuses on developing a variety with traits required in a region that delivers higher yield and quality grain
- Multiplication rate of inbred rice is high and with moderate bulk at 579 kg/m3 and moderate seed perishability, so production and transport costs are moderate
- Production of hybrid rice is very technically difficult, unlike in maize, and hybrid seed production technology and know-how do not exist at scale in Africa due to lack of technical capacity despite public sector interest

Research Capacity

Overview: *Numerous NARS work on improving local varieties and introducing improved varieties from international bodies such as AfricaRice (CGIAR), but generally lack the funding and capacity to implement rice breeding*

- **Research Institutes:** Breeding conducted almost exclusively through public institutions, such as the two NARIs in Ghana and DRD in Tanzania with no domestic private sector involvement in breeding
- **AfricaRice:** One of the CGIAR centers that develops new varieties and delivers breeder seed to NARS for introduction; almost all new varieties developed by AfricaRice and localized by NARS

Value Chain Challenges

Overview: *Disconnect between breeders, farmers, and end markets creates a mismatch between supply and demand which results in chronic underinvestment by the private sector*

- Currently little to no private sector actors involved in breeding, only public-to-public research collaboration
- Large markets demand high quality grain, while most farmers' use local varieties and produce grain full of impurities, so consumers prefer imported rice and linkages to farmers are weak, resulting in low market pull
- Post-harvest processing and handling issues reduce the return on investment in quality seed if grain is damaged post-harvest, resulting in lower future demand among farmers who do not have access to good technology
- Low demand offers little incentive for private production of foundation seed or quality seed, combined with lack of public capacity, results in chronically low supply that continues to hinder adoption
- Private sector is not involved in breeding, but does participate in seed production, and further opportunities exists if import substitution is encouraged and market linkages are promoted

Source: Boettiger, Sara et al. "Planning for Scale Brief #1: Tools for Scaling," Ag Partner Exchange, 2013, Figure 2, page 18; Interviews with crop and country experts

Sweet Potato: Inconsistent and unpredictable demand coupled with the ability to re-plant seeds year over year keep the production of sweet potato seed mostly limited to public entities

Sweet Potato

Sweet Potato Overview

Seed Attributes

Overview: *Sweet potatoes have a short growing period (only 3 months) making them good for food security, but are highly susceptible to disease and have short shelf life, making them expensive to transport and multiply*

- **Desirable Characteristics:** storability, cooking/frying quality, color, size, taste, drought/disease resistance, low fiber content, high dry matter content; OFSP is promoted by public sector, but not yet adopted by the market
- **End Uses:** consumption (fresh or fried), replanting
- Sweet potato seed demand fluctuates from year to year, a disincentive for the private market to invest
  - Demand typically spikes during a drought year as sweet potatoes are drought resistant and have a short growing period (3 months) good for food security, but the demand is not consistent
- A new variety takes 6-8 years to develop: critical for demand to be forecasted to ensure future needs are met
  - Localization of the breed is important as consumer demands are localized, but transportation costs of planting materials to local multiplication plots are high due to bulky nature of the crop
- Multiplication rates are relatively low (about 15-20 seeds per plant), high bulk, and high seed perishability– these are key constraints to private sector involvement

Research Capacity

Overview: *The International Potato Center provides germplasm and facilitates learning across countries*

- **International Potato Center:** Provides germplasm to local research institutes to be adapted locally; facilitates the sharing of regional varieties cross borders in some African countries (headquartered in Lima, Peru with offices in Asia, Africa, and Latin America); primarily promotes OFSP, rather than focusing on varieties demanded by markets
  - Local research facilities often lack adequate storage facilities and technical equipment (greenhouses)

Value Chain Challenges

Overview: *Sweet potatoes have unclear demand caused by farmers replanting seed year over year, free seed provided by NGOs, and spikes in demand during drought seasons, making it a difficult crop for private markets*

- Currently no private sector actors involved in research, only public-to-public research collaboration
- Farmers cannot be assured that seed from formal sector is clean and disease free due to lack of certification and quality assurance in many countries, decreasing demand for quality seed
  - When a farmer has a good variety, they will replant it for years, making demand unclear and unquantifiable
- Transportation from breeder to multiplication plots is costly due to bulky nature and short shelf life of the crop
- NGOs have historically provided sweet potato seed to farmers for free, creating the behavior that farmers are unwilling to pay for the seed

Source: Boettiger, Sara et al. "Planning for Scale Brief #1: Tools for Scaling," Ag Partner Exchange, 2013, Figure 2, page 18; Interviews with crop and country experts

Maize: As the mostly widely grown and consumed crop in Africa, maize has high support and investment from both national and intl donors for the development of new and improved varieties

Maize

Maize Overview

Seed Attributes

Overview: *Maize is the most widely grown staple crop in Africa and serves as the main food source*

- **Desirable Characteristics:** white maize, high yield, drought resistance, pest resistance, disease resistance
- **End Uses:** Mostly for consumption; some used for livestock feed and raw material for industrial products
- Maize is the most widely grown staple crop in Africa – more than 300 million Africans depend on it as their main food source
  - Africa produces ~50M tons of maize (6.5% of the world's maize supply), harvesting approximately 29M hectares; the largest African producer is Nigeria with nearly 8 million tons
  - Maize accounts for 30–50% of low-income household expenditures in Eastern and Southern Africa
  - High multiplication rate (~100 seeds per fruit), moderate bulk density at 721 kg/m, and low seed perishability

Research Capacity

Overview: *There is heavy involvement from research institutes and national programs in the development and dissemination of new and improved varieties of maize (drought, pest, disease resistant)*

- **International Institute of Tropical Agriculture (IITA):** An international research institute focused on developing high yielding and disease-resistant varieties that are adaptable to various agro-ecological zones in Sub-Saharan Africa
- **International Maize and Wheat Improvement Center (CIMMYT):** The leading center for research, development, and training in maize and wheat and in farming systems; provide most international germplasm
- **Water Efficient Maize for Africa (WEMA):** A public-private partnership (with national regulatory authorities) to develop drought-tolerant and insect-protected maize using conventional breeding, marker-assisted breeding, and biotechnology, with a goal to make these varieties available royalty-free to smallholder farmers in Sub-Saharan Africa through African seed companies
- **Drought Tolerant Maize for Africa (DTMA)**: A jointly implemented project by CIMMYT and IITA, in close collaboration with national agricultural research systems, to produce improved and drought resistant maize varieties and provide training and support to African Seed Producers
  - Have developed over 60 drought tolerant hybrid maize varieties, and ~60 drought tolerant OPV varieties
  - Funded by the Bill and Melinda Gates Foundation

Value Chain Challenges

Overview: *Threats from disease, pests, and drought add significant risk to the production of maize*

- Maize is susceptible to drought and disease (particularly Maize Streak Virus); pests can cause losses of 20-40% during cultivation and 30-90% losses postharvest and during storage; this adds risk to private investment

Source: Boettiger, Sara et al. "Planning for Scale Brief #1: Tools for Scaling," Ag Partner Exchange, 2013, Figure 2, page 18; Interviews with crop and country experts

Appendix

- **Business model assumptions**
- Primary and secondary sources

Summary of Financial Models and Assumptions

The following financial models detail the individual sources of revenue and cost that were used to arrive at our conclusions regarding the economics of each business model, as well as the assumptions underlying each. The data included in each business model differ slightly due to the different contexts of different seed sectors, as well as the data available from primary and secondary sources. The following set of assumptions guided all five business models:

- All costs and revenues are either based directly on figures from expert interviews or secondary sources, where available, or calculated based on assumptions applied to direct figures, which have been validated with experts
- Total quality seed production was held constant at 1,000 MT for ease of comparison
  - The exception to this rule is sweet potato, for which seed weight is a less relevant metric, so planted area (in acres) was used instead
- The number of distinct varieties produced does not have a material impact on the cost of production, per interviews with seed company executives
  - Incremental costs will be incurred for management, to ensure adequate isolation and no mixture, and for labor, to clean machinery and handling areas to avoid contamination, but these are relatively small costs
- For seed sectors which could likely be vertically integrated, either by a public or private entity, profitability for breeder or foundation seed was not calculated, as any sale of those seeds would be intra-firm; in particular:
  - We believe maize is likely to be produced by a vertically integrated private company and sorghum is likely to be produced solely by government entities, thus profitability is only calculated for quality seed
  - We believe rice, sweet potato, and cowpea is likely to be produced in collaboration between the public and private sectors, and thus the profitability at each stage of the value chain is relevant and is calculated

Source: Expert Interviews, Monitor Deloitte Analysis

Private	P/P
Niche	Public

1

Hybrid Maize in Zambia – Breeder Seed P&L

Breeder Seed Production Assumptions	
Production (kg)	98.04
Production (MT)	0.10
Yield (MT/ha)	0.75
Land (ha)	0.13

	Breeder Seed Production Economics	Cost		Assumptions
Fixed Costs	Salaries (researchers, technicians)	$	196,522.94	1 breeder per 25kg at $50,000, plus 2x technician costs vs. foundation seed
	Training (for researchers, technicians)	$	78,609.18	40% of salary
	Other Fixed Costs (staff, equipment, etc.)	$	413,642.50	Same fixed costs as for foundation seed, 20% higher than that for quality seed
Variable Costs	Irrigation Equipment	$	62.75	Same as quality seed
	Planting and Harvesting Labor/Training	$	209.15	260 man-days/ha at $6/ha plus $400 training cost/grower at 2ha/grower
	Planting and Harvesting Equipment	$	60.78	Same as quality seed
	Germplasm	$	105,000.04	3% royalty on quality seed sales
	Other inputs (fertilizers, herbicide, etc.)	$	250.98	Same as quality seed
Totals	**Total Variable Costs**	**$**	**105,583.70**	**(13%)**
	Total Fixed Costs	**$**	**688,774.62**	**(87%)**
	Total Costs	**$**	**794,358.32**	

Appendix	*Input Breakdown*	Cost (per ha)	
	Frontier Optima	$	110.00
	Atrazine	$	25.00
	Gramoxone	$	28.00
	Endosuphan	$	116.00
	Punch Extra	$	74.13
	Lime	$	53.33
	Comp D	$	320.00
	Urea	$	164.00
	Other Input Costs	$	1027.00
	Total	**$**	**1917.47**

Private	P/P
Niche	Public

1

Hybrid Maize in Zambia – Foundation Seed P&L

Foundation Seed Production Assumptions	
Production (kg)	2941.18
Production (MT)	2.94
Yield (MT/ha)	0.75
Land (ha)	3.92
Seed Requirement (kg/ha)	25.00
Breeder Seed Used (kgs)	98.04

	Foundation Seed Production Economics		Cost	Assumptions
Fixed Costs	Salaries (technicians)	$	6,600.00	1 technician at ~$4,200 plus one field worker at ~$2,400
	Training (for technicians)	$	2,640.00	40% of salary
	Other fixed costs (staff, equipment, etc.)	$	413,642.50	Same as quality seed
Variable Costs	Irrigation Equipment	$	1,882.35	Same as quality seed
	Planting and Harvesting Labor/Training	$	7,058.83	260 man-days/ha at $6/ha (2x quality seed cost) plus $400 training cost/grower at 2ha/grower
	Planting & Harvesting Equipment	$	4,823.53	Same as quality seed
	Quality Inspections	$	78.43	Same as quality seed
	Fertilizer & Herbicide	$	7,529.41	Same as quality seed
	Transportation	$	44.12	$0.2/km/MT at 75km
Totals	**Total Variable Costs**	**$**	**21,416.67**	**(5%)**
	Total Fixed Costs	**$**	**422,882.50**	**(95%)**
	Total Costs	**$**	**444,299.17**	

Sources:
(1) Zambia National Farmers' Union (ZNFU), enterprise budgets publication
(2) Seed Control and Certification Institute (SCCI), interviews
(3) Zambia Agricultural Research Institute (ZARI), interviews
(4) Zamseed, interviews
(5) Seed Co, interviews
(6) Monitor Deloitte Analysis

Private	P/P
Niche	Public

1

Hybrid Maize in Zambia – Quality Seed P&L

Quality Seed Production Assumptions

Production (kg)	1000000.35
Production (MT)	1000.00
Yield (MT/ha)	8.50
Land (ha)	117.65
Seed Requirement (kg/ha)	25.00
Foundation Seed Used (kgs)	2941.18

	Quality Seed Production Economics	**Cost / Revenue**	**Assumptions**
Revenue	Seed Sales (IP Sales)	$ 3,500,001.23	$3,500/MT
	Total Revenue	**$ 3,500,001.23**	
Fixed Costs	Staff, processing equipment/facilities, etc.	$ 413,642.50	50% of variable costs
Variable Costs	Irrigation Equipment	$ 56,470.61	$400/ha for electricity and $80/ha for repairs and maintenance (all input and grower labor costs equal $700, per Seed Co)
	Planting and Harvesting Labor and Training	$ 211,764.78	260 man-days/ha at $6/man-day (2x cost quoted by ZNFU) plus training costs of $400/grower, assume an average of 2 ha/grower
	Planting & Harvesting Equipment	$ 144,705.93	$570 for fuel (190L/ha at $3/L), $36 for oil (12L/ha at $3/L), $340/ha for combine hire, and $285 R&M (50% of fuel cost)
	Processing & Packaging Equipment	$ 7,000.00	$7/MT for bags/packing
	Quality Inspections	$ 2,352.94	$8/ha for registration, $1.5/test/sample for 4 tests/sample, 2 samples/ha
	Other Inputs (fertilizer, herbicide, etc.)	$ 225,882.43	All input and grower labor costs equal $700, per Seed Co, which is roughly ~4x the numbers given by ZNFU for maize grain
	Transportation (to foundation seed sites)	$ 15,000.01	$0.20/km/MT at 75km to transport back to center for processing
	Marketing	$ 15,000.01	Same as transportation cost above to redistribute to agents
	Crop Insurance	$ 35,000.01	1% of output
	Interest	$ 114,108.28	16% of total variable cost
Totals	**Total Variable Costs**	**$ 827,285.00**	**(67%)**
	Total Fixed Costs	**$ 413,642.50**	**(33%)**
	Total Costs	**$ 1,240,927.49**	
	Profit	**$ 2,259,073.73**	
	Margin (%)	**74%**	

Value Chain Totals	**Total Value Chain Costs**	**$ 2,479,584.98**	
	Total Value Chain Profit	**$ 1,020,416.24**	
	Total Value Chain Margin (%)	**29%**	

Private	P/P
Niche	Public

2a

Sweet Potato in Tanzania – Breeder Seed P&L

Breeder Seed Production Assumptions	
Production (bags)	150
Yield (bags/acre	60.00
Land (acre)	2.50
Multiplication Rate	20.00
Nucleus Seed Cuttings Used ($/yr)	$1,350.00

	Breeder Seed Production Economics	Cost / Revenue	Assumptions
Revenue	Seed Sales (IP Sales)	$ -	No revenue: given to foundation seed producers free
	Total Revenue	**$ -**	
Fixed Costs	Salaries (researchers and technicians)	$ 6,000.00	Based on one breeder/seed specialist; $6000 salary
	Training (for researchers and technicians)	$ 2,500.00	$2500 per breeder/seed specialist
	Travel (market research)	$ 350.00	$350 per breeder/seed specialist
	Land (for cultivating seed, include isolation)	$ 900.00	$900
Variable Costs	Germplasm	$ 1,350.00	$1350 per year
	Fertilizer	$ 170.00	170 per year
	Pesticides	$ 110.00	$110 per year
	Transportation (to foundation seed sites)	$ 170.00	170 per year
Totals	**Total Variable Costs**	**$ 1,800.00**	**(16%)**
	Total Fixed Costs	**$ 9,750.00**	**(84%)**
	Total Costs	**$ 11,550.00**	
	Profit	**$ (11,550.00)**	
	Margin (%)	**N/A**	

Sources:
(1) Richard Gibson Interview
(2) Nessie Luambano and Kibaha Researchers Interview
(3) Farm Concern International Seed-Farmer-Market Consumer Landscape Analysis Report 2014
(4) Expert Interviews
(5) Monitor Deloitte Analysis

Private	P/P
Niche	Public

2a

Sweet Potato in Tanzania – Foundation Seed P&L

Foundation Seed Production Assumptions	
Production (bags)	3,000.00
Yield (bags/acre)	60.00
Land (acre)	50.00
Multiplication Rate	20.00
Breeder Seed Used (bags)	150.00

	Foundation Seed Production Economics	**Cost / Revenue**	**Assumptions**
Revenue	Seed Sales (IP Sales)	$ 33,840.00	$11.28/bag based on FCI report
	Total Revenue	**$ 33,840.00**	
Fixed Costs	Salaries (researchers and technicians)	$ 9,750.00	Based on one breeder/seed specialist; $6000 salary + $75 per acre
	Training (for researchers and technicians)	$ 2,500.00	$2500 per breeder/seed specialist
	Land (for cultivating seed, include isolation)	$ 900.00	$900
Variable Costs	Irrigation Equipment	$ 1,500.00	$1500 per year
	Planting & Harvesting Equipment	$ 1,130.00	$1130 per year
	Quality Inspections (incl. virus indexing)	$ 270.00	$270 per year
	Breeder Seed	$ -	Given to foundation seed producers for free
	Fertilizer	$ 170.00	$170 per year
	Pesticides	$ 110.00	$110 per year
	Transportation (to foundation seed sites)	$ 170.00	$170 per year
Totals	**Total Variable Costs**	**$ 3,350.00**	**(20%)**
	Total Fixed Costs	**$ 13,150.00**	**(80%)**
	Total Costs	**$ 16,500.00**	
	Profit	**$ 17,340.00**	
	Margin (%)	**51%**	

Private	P/P
Niche	Public

2a

Sweet Potato in Tanzania – Quality Seed P&L

Quality Seed Production Assumptions	
Production (bags)	60,000.00
Land (acre)	1,000.00
Multiplication Rate	20.00
Foundation Seed Used (bags)	3,000.00

	Quality Seed Production Economics	Cost / Revenue		Assumptions
Revenue	Seed Sales (IP Sales)	$	507,600.00	$8.46 per bag
	Total Revenue	**$**	**507,600.00**	
Fixed Costs	Salaries (research scientists and technicians)	$	75,000.00	Harvesting, guarding, and ridging; $75 per acre
Variable Costs	Land (for cultivating seed - include isolation)	$	10,000.00	$10 per acre
	Irrigation Equipment	$	80,000.00	$80 per acre
	Quality Inspections (incl. virus indexing)	$	270.00	$270 per year
	Foundation Seed	$	33,840.00	$11.28/bag based on FCI report
	Fertilizer	$	25,000.00	$25 per acre
	Pesticides	$	10,000.00	$10 per acre
	Transportation (to foundation seed sites)	$	10,000.00	$10 per acre
Totals	**Total Variable Costs**	**$**	**169,110.00**	**(69%)**
	Total Fixed Costs	**$**	**75,000.00**	**(31%)**
	Total Costs	**$**	**244,110.00**	
	Profit	**$**	**263,490.00**	
	Margin (%)	**$**	**52%**	
		$		
Value Chain Totals	**Total Value Chain Revenue**	**$**	**541,440.00**	
	Total Value Chain Cost	**$**	**272,160.00**	
	Total Value Chain Profit	**$**	**269,280.00**	
	Total Value Chain Margin (%)	**$**	**50%**	

Private	P/P
Niche	Public

2a

Rice in Nigeria – Breeder Seed P&L

Breeder Seed Production Assumptions	
Production (kg)	156.25
Production (MT)	0.16
Yield (MT/ha)	8.00
Land (ha)	0.02
Multiplication Rate	80.00
Seeding Rate (kg/ha)	100.00
Nuclear Seed Used (kg)	1.95

	Breeder Seed Production Economics	Cost / Revenue		Assumptions
Revenue	Seed Sales	$	8,203.13	$105 for 2kgs
	Total Revenue	**$**	**8,203.13**	
Fixed Costs	Salaries (researchers and technicians)	$	40,200.00	Breeder salary: $18,000; technician salary: $4,200; assumes two breeders and one technician
	Training (for researchers and technicians)	$	20,210.00	$10,000 per breeder, $210 per technician
	Land (for cultivating breeder seed)	$	421.00	$421 per HA rented
	Office/lab Space	$	421.00	$421 rented per year
	Lab Equipment	$	790.00	$790 for lab equipment per year
Variable Costs	Germplasm	$	53.00	$53 per HA planted
	Fertilizer	$	300.00	$30 per bag, 10 bags needed
	Transportation (to foundation seed sites)			No information provided
Totals	**Total Variable Costs**	**$**	**353.00**	**(1%)**
	Total Fixed Cost	**$**	**62,042.00**	**(99%)**
	Total Costs	**$**	**62,395.00**	
	Profit	**$**	**(54,191.88)**	
	Margin (%)		**-661%**	

Sources:
(1) Osiname Olumuyiwa Interview
(2) George Zangir, Value Seeds Interview
(3) Expert Interviews
(4) Monitor Deloitte Analysis

Private	P/P
Niche	Public

2a

Rice in Nigeria – Foundation Seed P&L

Foundation Seed Production Assumptions	
Production (kg)	12500.00
Production (MT)	12.50
Yield (MT/ha)	8.00
Land (ha)	1.56
Multiplication Rate	80.00
Seeding Rate (kg/ha)	100.00
Breeder Seed Used (kgs)	156.25

	Foundation Seed Production Economics	Cost / Revenue	Assumptions
Revenue	Seed Sales (IP Sales)	$ 28,750.00	$115 for 50kgs
	Total Revenue	**$ 28,750.00**	
Fixed Costs	Salaries (research scientists and technicians)	$ 12,600.00	$4200 per seed technician; assumes three
	Training (for research scientists and technicians)	$ 630.00	$210 per technician
	Land (for planting breeder seed)	$ 657.81	$421 per HA (rented)
	Irrigation Equipment	$ 578.13	$370 per HA
	Planting & Harvesting Equipment	$ 5,268.00	$5268 per thresher; estimated one for every 2 HA
Variable Costs	Quality Inspections	$ 7.81	$5 per HA
	Breeder Seed	$ 8,203.13	$105 for 2kgs of breeder seed
	Fertilizer	$ 300.00	$30 per bag, 10 bags needed
	Transportation (to foundation seed sites)		No information provided
	Processing & Storage		No information provided
Totals	**Total Variable Costs**	**$ 8,510.94**	**(30%)**
	Total Fixed Costs	**$ 19,733.94**	**(70%)**
	Total Costs	**$ 28,244.88**	
	Profit	**$ 505.13**	
	Margin (%)	**2%**	

Private	P/P
Niche	Public

2a

Rice in Nigeria – Quality Seed P&L

Quality Seed Production Assumptions	
Production (kg)	1000000.00
Production (MT)	1000.00
Yield (MT/ha)	8.00
Land (ha)	125.00
Multiplication Rate	80.00
Seeding Rate (kg/ha)	100.00
Foundation Seed Used (kgs)	12500.00

	Quality Seed Production Economics	Cost / Revenue	Assumptions
Revenue	Seed Sales (IP Sales)	$ 1,220,000.00	Gov buys at $1.32/kg; open market buys at $1.11/kg; median used ($1.22)
	Total Revenue	**$ 1,220,000.00**	
Fixed Costs	Salaries (outgrowers)	$ 300,000.00	$2400 per field worker; estimate one field worker per HA
	Training (outgrowers)	$ 26,250.00	$210 per outgrower, 1 per HA
Variable Costs	Land (for planting foundation seed)	$ 52,625.00	$421 per hectar
	Irrigation Equipment	$ 46,250.00	$370 where there are no irrigation facilities
	Planting & Harvesting Equipment	$ 329,250.00	$5268 per thresher; estimated one for every 2 HA
	Quality Inspections	$ 625.00	$5 per hectar
	Foundation Seed	$ 28,750.00	$2300 per MT
	Fertilizer	$ 300.00	$30 per bag, 10 bags needed
Totals	**Total Variable Costs**	**$ 457,800.00**	**(58%)**
	Total Fixed Costs	**$ 326,250.00**	**(42%)**
	Total Costs	**$ 784,050.00**	
	Profit	**$ 435,950.00**	
	Margin (%)	**36%**	

Value Chain Totals	**Total Value Chain Revenue**	**$ 1,256,953.13**	
	Total Value Chain Costs	**$ 874,689.88**	
	Total Value Chain Profit	**$ 382,263.25**	
	Total Value Chain Margin (%)	**30%**	

Private	P/P
Niche	Public

2b

Cowpea in Ghana – Breeder Seed P&L

Breeder Seed Production Assumptions	
Production (kg)	625.00
Production (MT)	0.63
Yield (MT/ha)	1.20
Land (ha)	0.52
Multiplication Rate	40.00
Seeding Rate (kg/ha)	30.00
Nuclear Seed Used (kg)	15.63

	Breeder Seed Production Economics	Cost / Revenue		Assumptions
Revenue	Seed Sales	$	1,875	$3,000 per MT
	Total Revenue	**$**	**1,875**	
Fixed Costs	Salaries (research scientists and technicians)	$	100,000	$50,000 breeder salary, 2 breeders full-time
	Training (for researchers and technicians)	$	40,000	$20,000 per breeder for training
	Travel (market research)	$	1,000	$500 per breeder
	Land (for cultivating breeder seed)	$	20,000	Based on data from expert interviews
	Office/lab Space	$	50,000	Based on data from expert interviews
	Lab Equipment	$	426	$682 per MT produced: based on data from expert interviews
Variable Costs	Germplasm	$	60,000	3% sales royalties
	Fertilizer	$	327	$523 per MT
	Pesticides	$	2,000	Based on data from expert interviews
	Transportation (to foundation seed sites)	$	1,000	Based on data from expert interviews
Totals	**Total Variable Costs**	**$**	**63,327**	**(23%)**
	Total Fixed Costs	**$**	**211,426**	**(77%)**
	Total Costs	**$**	**274,753**	
	Profit	**$**	**(272,878)**	
	Margin (%)		**-14554%**	

Sources:

(1) Bejamin Kemetse, M&B Seeds, Interview
(2) Kwabena Adu-gyamfi, Seed Trade Association President, Interview
(3) Dr. James Asibuo Interview
(4) M.B. Mochiah, CSIR, Interview
(5) Expert Interviews
(6) Monitor Deloitte Analysis

Private	P/P
Niche	Public

2b

Cowpea in Ghana – Foundation Seed P&L

Foundation Seed Production Assumptions	
Production (kg)	25000.00
Production (MT)	25.00
Yield (MT/ha)	1.20
Land (ha)	20.83
Multiplication Rate	40.00
Seed Requirement (kg/ha)	30.00
Breeder Seed Used (kgs)	625.00

	Foundation Seed Production Economics	Cost / Revenue		Assumptions
Revenue	Seed Sales (IP Sales)	$	75,000	$3,000 per MT
	Total Revenue	**$**	**75,000**	
Fixed Costs	Salaries (research scientists and technicians)	$	20,000	$20,000 per breeder, 1 breeder assumed
	Land and facilities	$	40,000	40000 for land, Based on data from expert interviews
Variable Costs	Irrigation Equipment	$	154	$246 per MT planted: based on data from expert interviews
	Planting & Harvesting Equipment	$	273	$436 per MT planted: based on data from expert interviews
	Quality Inspections	$	300	$12 per MT produced: based on data from expert interviews
	Breeder Seed	$	1,875	$3000 per MT: based on data from expert interviews
	Fertilizer	$	327	$523 per planted based on data from expert interviews
	Pesticides	$	347	$555 per MT planted: based on data from expert interviews
	Transportation (to foundation seed sites)	$	2,050	$82 per MT produced: based on data from expert interviews
	Processing & Storage	$	11,125	$445 per MT produced: based on data from expert interviews
Totals	**Total Variable Costs**	**$**	**16,450**	**(22%)**
	Total Fixed Costs	**$**	**60,000**	**(78%)**
	Total Costs	**$**	**76,450**	
	Profit	**$**	**(1,450)**	
	Margin (%)	**$**	**-2%**	

Private	P/P
Niche	Public

2b

Cowpea in Ghana – Quality Seed P&L

Quality Seed Production Assumptions	
Production (kg)	1000000.00
Production (MT)	1000.00
Yield (MT/ha)	1.20
Land (ha)	833.33
Multiplication Rate	40.00
Seeding Rate (kg/ha)	30.00
Foundation Seed Used (kgs)	25000.00

	Quality Seed Production Economics	Cost / Revenue	Assumptions
Revenue	Seed Sales (IP Sales)	$ 2,000,000	$2,000 per MT: based on given data
	Total Revenue	**$ 2,000,000**	
Fixed Costs	Staff, processing equipment/facilities, etc.	$ 323,000	$323 per MT produced: based on data from expert interviews
Variable Costs	Land (for planting foundations eed)	$ 3,875	$155 per MT planted: based on data from expert interviews
	Irrigation Equipment	$ 6,150	$246 per MT planted: based on data from expert interviews
	Planting & Harvesting Equipment	$ 10,900	$436 per MT planted: based on data from expert interviews
	Processing & Packaging Equipment	$ 445,000	$445 per MT produced: based on data from expert interviews
	Quality Inspections	$ 12,000	$12 per MT produced: based on data from expert interviews
	Foundation Seed	$ 75,000	$3000 per MT: based on data from expert interviews
	Fertilizer	$ 13,075	$523 per MT planted: based on data from expert interviews
	Pesticides	$ 13,875	$555 per MT planted: based on data from expert interviews
	Transportation (to foundation seed sites)	$ 82,000	$82 per MT produced: based on data from expert interviews
	Marketing	$ 138,000	$138 per MT produced: based on data from expert interviews
Totals	**Total Variable Costs**	**$ 799,875**	**(71%)**
	Total Fixed Costs	**$ 323,000**	**(29%)**
	Total Costs	**$ 1,122,875**	
	Profit	**$ 877,125**	
	Margin (%)	**44%**	

Value Chain Totals	**Total Value Chain Revenue**	**$ 2,076,875.00**	
	Total Value Chain Costs	**$ 1,474,078.13**	
	Total Value Chain Profit	**$ 602,796.88**	
	Total Value Chain Margin (%)	**29%**	

Private	P/P
Niche	**Public**

3

Sorghum in Ethiopia – Breeder and Foundation Seed P&L

Breeder Seed Production Assumptions

Production (kg)	25.00
Production (MT)	0.03
Yield (MT/ha)	3.00
Land (ha)	0.01

	Breeder Seed Production Economics		Cost	Assumptions
Fixed Costs	Breeder Salary	$	50,000.00	1 breeder full-time equivalent at $50,000
	Other Fixed Costs (facilities, processing, etc)	$	51,800.00	Same fixed costs as quality seed
Variable Costs	Total Variable Cost excl. bagging, transport	$	1,362.00	$1362 (given)
	Bagging	$	3,000.00	$3000 (based on $9000 for bags that last three years)
	Transportation (to foundation seed sites)	$	100.00	$0.2/km/MT, average 500km, with minimum 1MT
Totals	**Total Variable Cost**	**$**	**4,462.00**	**(4%)**
	Total Fixed Cost	**$**	**101,800.00**	**(96%)**
	Total Costs	**$**	**106,262.00**	

Foundation Seed Production Assumptions

Production (kg)	5000.00
Production (MT)	5.00
Yield (MT/ha)	3.00
Land (ha)	1.67
Seed Requirement (kg/ha)	15.00
Breeder Seed Used (kgs)	25.00

	Foundation Seed Production Economics		Cost	Assumptions
Fixed Costs	Fixed Costs (facilities, equipment, etc.)	$	51,800.00	Same fixed costs as quality seed
Variable Costs	Total Variable Cost excl. transport	$	2,953.33	$1772/ha (given)
	Transportation (to quality seed sites)	$	250.00	$0.2/km/MT, average 250km, with minimum 1MT
Totals	**Total Variable Cost**	**$**	**3,203.33**	**(6%)**
	Total Fixed Cost	**$**	**51,800.00**	**(94%)**
	Total Costs	**$**	**55,003.33**	

Private	P/P
Niche	**Public**

3

Sorghum in Ethiopia – Quality Seed P&L

Quality Seed Production Assumptions	
Production (kg)	1000000.00
Production (MT)	1000.00
Yield (MT/ha)	3.00
Land (ha)	333.33
Seed Requirement (kg/ha)	15.00
Foundation Seed Used (kgs)	5000.00

	Quality Seed Production Economics	**Cost / Revenue**	**Assumptions**
Revenue	Seed Sales (IP Sales)	$ 220,000.00	Assume farmers get 60% discount off already subsidized price of $55/quintal ($0.55/kg), which is the midpoint of given range 45-65
	Total Revenue	**$ 220,000.00**	
Fixed Costs	Fixed Costs (processing, equipment, etc.)	$ 51,800.00	30% of total variable costs
Variable Costs	Total Variable Cost excl. transport	$ 147,666.67	$886/ha (50% of given value for foundation seed)
	Transportation (to farmers/agro-dealers)	$ 25,000.00	$0.2/km/MT, average 125km, with minimum 1MT
Totals	**Total Variable Cost**	**$ 172,666.67**	**(77%)**
	Total Fixed Cost	**$ 51,800.00**	**(23%)**
	Total Costs	**$ 224,466.67**	
	Profit	**$ (4,466.67)**	
	Margin (%)	**-2%**	
Value Chain Totals	**Total Value Chain Cost**	**$ 385,732.00**	
	Total Value Chain Profit	**$ (165,732.00)**	
	Total Value Chain Margin (%)	**-75%**	

Sources:
(1) ISSD Ethiopia, interviews
(2) Ethiopian Agricultural Research Institute (EIAR), interviews
(3) Monitor Deloitte Analysis

Appendix

- Business model assumptions
- **Primary and secondary sources**

Interviews: Zambia

Name	Organization	Area of Expertise		Connection
		Country	Crop	
George Bigirwa	AGRA	Zambia	Maize	BMGF Contact
Tsedeke Abate	DTMA	Zambia	Maize	BMGF Contact
Indira Ekanayake	World Bank	Zambia	Maize	World Bank
Dr. Tobbi Kamwale	Zamseed	Zambia	Maize	Pietro C Carpena
Elia Manda	Self Help Africa	Zambia	Maize	Pietro C Carpena
Pietro C Carpena	Self Help Africa	Zambia	Maize	BMGF Contact
Chance Kabaghe	IAPRI	Zambia	Maize	BMGF Contact
Richard Chapple	AGCO Corporation	Zambia	Maize	Monitor Deloitte
Rob Vanhoucke	AGCO Corportation	Zambia	Maize	Richard Chappel
Francisco Miti	SCCI	Zambia	Maize	BMGF Contact
Moses Mwale	ZARI	Zambia	Maize	Tsedeke Abate
Dr. Meshi	ZARI	Zambia	Maize	Moses Mwale
Dr. Peter Setimela	CIMMYT	Zambia	Maize	Tsedeke Abate
Godfrey Mwila	ZARI	Zambia	Maize	Moses Mwale
Mable Simwanza	ZARI	Zambia	Maize	Moses Mwale
John Muhuha	COMESA	Zambia	Maize	ZARI
Anna Tonnes	USAID	Zambia		USAID Contact
Louise Sperling	CRS	Zambia, Ethiopia, Tanzania		USAID and BMGF Contact
Total Zambia Interviews:	***18***			

Interviews: Tanzania

Name	Organization	Area of Expertise		Connection
		Country	Crop	
Nessie Luambano	Kibaha SRI/Mikocheni ARI	Tanzania	Sweet Potato	Margaret McEwan
Richard Gibson	Natural Resources Institute	Tanzania	Sweet Potato	BMGF Contact
Lembris Laizer	CRS	Tanzania	Sweet Potato	Richard Gibson
Everina Lukonge	LZARDI	Tanzania	Sweet Potato	Richard Gibson
Margaret McEwan	CIP	Tanzania	Sweet Potato	BMGF Contact
Lauren Good	MEDA	Tanzania	Sweet Potato	BMGF Contact
Wilfred Mushobozi	Crop Bioscience	Tanzania	Sweet Potato	BMGF Contact
Kiddo Mtunda	IITA	Tanzania	Sweet Potato	BMGF Contact
Mohammed Msabaha	BMGF Advisor	Tanzania	Sweet Potato	BMGF Contact
Jan Low	CIP	Tanzania	Sweet Potato	BMGF Contact
Justin Ringo	DRD	Tanzania	Sorghum	BMGF Contact
Betty Maeda	USAID	Tanzania		USAID Contact
Suzanne Poland	USAID	Tanzania		USAID Contact
Erasto Mlay	BMGF Advisor	Tanzania	Legumes, Sorghum	BMGF Contact
Catherine Madata	BMGF Advisor	Tanzania	Beans	BMGF Contact
Jean Claude Rubyogo	CGIAR	Tanzania and Ethiopia	Beans	BMGF Contact
Total Tanzania Interviews:	***16***			

Interviews: Ethiopia

Name	Organization	Area of Expertise		Connection
		Country	Crop	
Amare Nega	EIAR	Ethiopia	Sorghum	BMGF Contact
Mr. Habte Nida	EIAR	Ethiopia	Sorghum	Amare Nega
Mohammed Hassenabeko	Wageningen	Ethiopia	Sorghum	BMGF Contact
George Okwach	CGIAR: Hope Coordinator	Ethiopia	Sorghum	BMGF Contact
Fasil Reda	ATA	Ethiopia	Sorghum	Amsale Mengistu
Genzeb Akele	ATA	Ethiopia	Sorghum	Amsale Mengistu
Dagne Wegary	CIMMYT	Ethiopia	Sorghum	Tsedeke Abate
Taye Tessema	Purdue University	Ethiopia	Sorghum	Mohammed Hassena Beko
Asfaw Adugna	Advanta Seed International	Ethiopia	Sorghum	George Okwach
Tracy Powell	USAID	Ethiopia	Sorghum	USAID Contact
Nathanael Bascom	Kansas State University	Ethiopia	Sorghum	Tracy Powell
Abdallah Mohamed	ICRISAT	Ethiopia	Sorghum	BMGF Contact
Adam Silagyi	USAID	Ethiopia		USAID Contact
Pascal Joannes	UN WFP	Ethiopia		Monitor Deloitte
Ravi Shankar	ATA	Ethiopia		Monitor Deloitte
Total Ethiopia Interviews:	***15***			

Interviews: Ghana

Name	Organization	Area of Expertise		Connection
		Country	Crop	
Abdulai Antiku	Antika Co.	Ghana	Cowpea	Hailu Tefera
Benjamin Kemetse	M&B Seeds	Ghana	Cowpea	Hailu Tefera
Stephen Nutsugah	CSIR	Ghana	Cowpea	USAID Contact
Alex Bokuma	Lebox Investments	Ghana	Cowpea	Hailu Tefera
Ousmane Boukar	IITA	Ghana	Cowpea	USAID Contact
Hailu Tefera	USAID	Ghana	Cowpea	USAID Contact
Hans Jansen	World Bank	Ghana	Cowpea	World Bank
Prof. Charles Quansah	ISSD Ghana Task Force	Ghana	Cowpea	Abishkar Subedi
Mr. Kwabena Adu-Gyamfi	Seed Trade Assoc. of Ghana	Ghana	Cowpea	Abishkar Subedi
Dr. James Asibuo	CSIR	Ghana	Cowpea	Professor Charles Quansah
Dr. Mochiah	CSIR	Ghana	Cowpea	Professor Charles Quansah
Abishkar Subedi	Wageningen	Ghana	Cowpea	BMGF Contact
Alpha Kamara	IITA	Ghana	Cowpea	BMGF Contact
Brian Conklin	USAID	Ghana		USAID Contact
John Brighenti	USAID	Ghana		USAID Contact
Richard Jones	AGRA	Ghana, Ethiopia, Tanzania		USAID Contact
Total Ghana Interviews:	***16***			

Interviews: Nigeria and Other

Name	Organization	Area of Expertise		Connection
		Country	Crop	
Osiname Olumuyiwa	Seed Council	Nigeria	Rice	Monitor Deloitte
Dr. Ojo	Seed Council	Nigeria	Rice	Monitor Deloitte
Maina Seed	Maina Seeds	Nigeria	Rice	Secondary Research
George Zangir	Value Seeds Ltd.	Nigeria	Rice	Secondary Research
James Legg	CGIAR	Nigeria	Cassava, Sweet Potato	BMGF Contact
Professor Mary Yeye	IAR	Nigeria	Sorghum	BMGF Contact
Dai Peters	CRS	Nigeria, Ghana	Cassava, Sweet Potato	BMGF Contact
Kedera Chagema	BMGF Advisor	Kenya		BMGF Contact
Samuel Kugbei	FAO	Sierra Leone	Cowpea	Hans Jansen
Issoufou Kapran	AGRA	West Africa	Maize	BMGF Contact
Mark Edge	Monsanto			Interview Recommendation
Marco Wopereis	CGIAR		Rice	BMGF Contact
Sara Boettiger	BMGF			BMGF Contact
Paul Kiepe	CGIAR: Africa Rice Center		Rice	BMGF Contact
Vern Long	USAID		Common Beans, Cowpeas	USAID Contact
John McMurdy	USAID		Maize	USAID Contact
Total Nigeria and Other Interviews:	***17***			
Total Interviews:	***82***			

Individuals Not Reached (Ethiopia and Ghana)

Name	Organization	Area of Expertise		Connection
		Country	Crop	
Yitbarek Semeane	ATA	Ethiopia	Sorghum	BMGF Contact
Assaye Legesse	World Bank	Ethiopia	Sorghum	World Bank
Adane G/Yohannes	Melkassa	Ethiopia	Sorghum	Fasil Reda
Brihanu Atomsa	Fedis Research Center	Ethiopia	Sorghum	Mohammed Hassena Beko
Dr Snake Fikre	Ethiopia Institute of Agricultural Research	Ethiopia	Sorghum	George Okwach
Dr. Tefasse Gebru	Ethiopian Seed Enterprise (ESE)	Ethiopia	Sorghum	Asfaw Adugna
Yonas Sahlu	ATA	Ethiopia	Sorghum	Monitor Deloitte
Dr. Aga	EIAR	Ethiopia	Sorghum	Nathanael Bascom
Timothy Dalton	EIAR	Ethiopia	Sorghum	Tracy Powell
Andrew Paterson	EIAR	Ethiopia	Sorghum	Tracy Powell
Cullen Hughes	USAID	Ethiopia		USAID Contact
Abdulai Salifu	CSIR	Ghana	Cowpea	USAID Contact
Zakaria Sumani	Heritage Seeds Co.	Ghana	Cowpea	Hailu Tefera
Tahirou Abdoulaye	CGIAR	Ghana	Cowpea	Osumane Boukar
Ousmane Coulibaly	CGIAR	Ghana	Cowpea	Osumane Boukar
Dr . Amoah	CSIR	Ghana	Cowpea	Professor Charles Quansah
Dr. Hans Adu-Dapaah	CSIR	Ghana	Cowpea	Professor Charles Quansah
Mr. Osei Bonsu	CSIR	Ghana	Cowpea	Professor Charles Quansah
Dr. Emmanuel Moses	CSIR	Ghana	Cowpea	Professor Charles Quansah
Dr. Haruna Braimah	CSIR	Ghana	Cowpea	Professor Charles Quansah
Dr. Asuboah	CSIR	Ghana	Cowpea	Professor Charles Quansah
Mr. Kwabena Adu Gyamfi	Private Sector	Ghana	Cowpea	Professor Charles Quansah
Itai Makanda	AGRA	Ghana, Ethiopia, Tanzania		USAID Contact
Contacted with No Response:	***25***			

Individuals Not Reached (Nigeria, Zambia, and Other)

Name	Organization	Area of Expertise		Connection
		Country	Crop	
SADC Seed Center	SADC Seed Center	Multi	Multi	Secondary Research
Dr. Eniayeju	FDA	Nigeria	Rice	Monitor Deloitte
Sule Ochai	Seed Council	Nigeria	Rice	Monitor Deloitte
Abdoulaye Toure	World Bank	Nigeria	Rice	World Bank
Premier Seed	Premier Seed	Nigeria	Rice	Secondary Research
Mr. Muoneke	NPDC	Nigeria	Rice	Secondary Research
Seed Project Company	Seed Project Company Ltd.	Nigeria	Rice	Secondary Research
Mr. Atar	Seed Association of Nigeria	Nigeria	Rice	Secondary Research
Mohammed Abubakar	UMZA Farms	Nigeria	Rice	Monitor Deloitte
Charles Ugwuh	Tara	Nigeria	Rice	Monitor Deloitte
Robert Asiedu	CGIAR	Nigeria	Cassava, Sweet Potato	BMGF Contact
Regina Kapinga	BMGF	Tanzania	Sweet Potato	BMGF Contact
Adventina Babu	LZARDI	Tanzania	Sweet Potato	Margaret McEwan
Zainab Z. Semgalawe	World Bank	Tanzania	Sweet Potato	World Bank
Mr. Dominic Daka	Kamano Seed Company	Zambia	Maize	George Bigirwa
Mrs Stephanie Angomwile	Steward Globe	Zambia	Maize	George Bigirwa
Dr. Kennedy Muimui	Misamfu Regional Research St.	Zambia	Maize	Pietro C Carpena
Ed Zulu	Self Help Africa	Zambia	Maize	BMGF Contact
Dr. Mungoma	SCCI	Zambia	Maize	BMGF Contact
Dr. Cosmos Magorokosho	CIMMYT	Zambia	Maize	Tsedeke Abate
Kabamba Mwansa	ZARI	Zambia	Maize	Moses Mwale
Erin Shutty	USAID	Zambia		USAID Contact
Jennifer Harte	USAID		Cereals	USAID Contact
Nora Lapitan	USAID		Cereals	USAID Contact
Saharah Moon Chapotin	USAID		Cereals	USAID Contact
Hailu Tefera	USAID		Common Beans, Cowpeas	USAID Contact
Laura Schreeg	USAID		Common Beans, Cowpeas	USAID Contact
Contacted with No Response:	***27***			
Total Contacted with No Response:	***52***			